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# THE UNKNOWABLE;
OR,
# THE RELIGION OF SCIENCE.

BY RICHARD A. PROCTOR.

And still the skies are opened as of old
To the entrancèd gaze, ay, nearer far
And brighter than of yore; and might is there,
And Infinite Purity is there, and high
Eternal Wisdom, and the calm clear face
Of Duty, and a higher, stronger Love
And light in one, and a new, reverend Name,
Greater than any and combining all;
And over all, veiled with a veil of cloud,
God set far off, too bright for mortal eyes.—MORRIS.

## INTRODUCTION.

THE belief prevails that men of science, and those who accept the teachings of science, do not view religion from the same direction as those did who in old times were ignorant of the greater part of what is now known. It is supposed, further, that the religion of the world, or at least of the civilised world, is threatened, through the progress of science, with a change which would mean something like destruction.

In reality the human race has regarded religion always, so far back as the evidence shows, from the same direction, though what they have seen has altered in aspect as their range of view has increased.

To speak of a conflict between religion and science, is much as though one should speak of a conflict between our view of the universe we have surveyed and our ideas respecting the infinities of space which remain unsurveyed—including those which are unsurveyable through distance. Science means the knowledge which we have, the study of science is the search after such knowledge as we may have. Religion on the other hand depends in the main on the impression produced by what is not known, including always the knowable, but presenting itself more and more clearly to us as in infinitely larger degree unknowable. How can we look at the unknown save from the region of the known? And how can there possibly arise a contest between zeal for knowledge and awe in presence of the unknown?

If science in its steady progress promised or threatened—which should we rather say?—to interpret all things; if the domain of the unknown were ever growing less and less as the domain of the known grows larger and larger, then perhaps men might recognise—not indeed a conflict between religion and science, but—a possibility that such a conflict might arise. The case, however, is not only otherwise, it is the very reverse of this. The domain of the known is, indeed, growing wider and wider, as was foreseen in old times by him who wrote that "Men should run to and fro, and Knowledge be increased": but with the growth of knowledge has come ever clearer and clearer recognition of the truth that the known, let it grow as it may, must always be as nothing compared with the unknown. In old times men thought they knew much; Newton and Laplace said the known is little; the man of science of to-day says the known is nothing. In old times men thought the unknown little; Newton and Laplace said the unknown is immense; to-day science says the unknown is infinite.

In no sense do we stand, now, in any different position towards religion than was occupied by men a century ago, or a thousand years ago, or when as yet the child-man had but begun to look from what he knew towards the mysterious unknown, from his little spot of surveyed ground to the distant hills as yet unexplored, to the mountains beyond them, to the expanse of ocean seen between the mountain slopes, to the ocean horizon, to the cloud-laden air, and between the clouds to the infinite depths of star-strewn space. We have surveyed a wider region than men of old times. What seemed in past ages unknowable we understand and know. Phenomena that once men explained as supernatural we have learned to interpret as due to natural agencies. What men recognised as due to the direct intervention of deity we see to follow from the operation of law. Where men in old times bared their feet, as judging that they stood on holy ground, we have boldly advanced, as if hoping to approach "the Throne itself where Wisdom reigns supreme." But we have not approached that Throne; for its distance is infinite. We have not entered on holier ground; the ground on which we stood was already holy. We have not interpreted the laws that we have recognised; or only to recognise higher laws beyond our

interpretation. We have learned but to understand phenomena, not that which lies in and through and beyond all phenomena. The prayer of our poet has been fulfilled, or rather it has fulfilled itself. Knowledge has grown "from more to more"—and as a necessary consequence, "more of reverence in us dwells." The man of old times stood entranced before the beauty of the world he saw, stood appalled before the mystery which lay veiled beyond that world: even when imagining the power partly revealed to him as Man-like—in purpose, plan, and passions—the child-man "found religion." How shall the man who sees the grander world disclosed by science, who feels the infinitely greater mystery now veiled beyond the known, who recognises Deity as not measurable or even conceivable by our powers, fail to be moved, nay to be far more deeply moved than men were of old, by religious emotion?

When science in our times passes farther along the same path the same objections are naturally raised. As men in Moses' time might have pleaded for their more easily understood gods and their more obviously enforced duties; as they might have urged that the Jehovah of Moses was by comparison the merest abstraction, with nothing to appeal directly to their senses and their fears such as the gods of Nature had presented; so, many imagine now that there is something much more directly appealing to the emotions, something much more easily understood, in some one or other of the multitudinous beliefs adopted by various bodies, Christian, Mussulman, or Buddhist, than in the Infinities revealed by Science. "I am not moved by the sense of infinite power and mystery," a Mahomedan may say, "but the thought of Allah teaching and leading us through Mahomet is one I can understand and be moved by." So another may find in the idea that Faith in some special dogma is what he must cling to as all-saving, a doctrine more simple, and a guide to conduct more trustworthy, he imagines, than he would have in the recognition of Infinity of Power pure and simple,—in which he finds no other guide to duty than the partly inherited partly acquired conviction (though that conviction permeates the whole being and consciousness of the student of science), that there is a Power outside ourselves making for Righteousness, and that not only the sense of duty but the desire for our own and others' welfare, urges to justice and purity of conduct.

But—an objector will say—"the sense of awe and wonder experienced, be it admitted, by the man of science has no religious value; men cannot worship the unknowable, their conduct cannot be influenced by the consciousness that the universe is infinite, its duration eternal, its energies immeasurable, its variety and vitality inconceivable; such thoughts cannot bring men nearer together in the bonds of kindly fellowship, cannot strengthen men for life's struggle, cannot enable them better to endure life's troubles and sorrows,—in fine men cannot by the contemplation of the infinite mysteries of the universe be made better or braver, worthier or purer."

If we try to answer honestly the question how men have been moved or strengthened or purified by religious emotions in past ages, I do not think we shall be led thus to reject as of small religious value or of none, the impressions produced by the study and the teachings of modern science. It seems to me that men might with fully as much force, that is with no force at all, have raised a similar objection when, for the direct worship of the sun and moon and stars, advanced thinkers strove to substitute the worship of one God, by whom sun, moon, and stars were made. "How can religious emotion be raised," an ancient Chaldæan or Egyptian might have urged, "by what I cannot see? The moon walking in brightness among the fixed stars over which she is queen, the sun glorying as a giant to run his course, the stars (by which he would mean of course the planets, 'as they pursue their wandering course, now high now low then hid, progressive retrograde and standing still') these are manifest powers, though I may not know how they act. These I can worship, these I can propitiate by offering them sacrifice, and in presence of these I must guide my conduct aright, lest they be angry with me and smite me with their unseen arrows. Even if some among us might still be moved by religious emotion, still be strong and brave to endure the sorrows and trials of life, and still be pure in life and conduct, though recognising in the gods of heaven only symbols of a higher power, such as you proclaim, how shall the ignorant and the weak be strengthened and purified, by such an abstraction as you present? Beware how you shake men's faith in that which has so long strengthened them amidst life's trials, and kept them clear of offence, alike towards those glorious beings whom they worship and towards their fellow men."

The same objection was probably raised when other systems of specific nature-worship were attacked. It is well known even that idol-worship was defended against those who sought to purify religion from what seems so obviously unreasonable and contemptible. To this day there are countries where the priesthood of the Roman Church are unwilling to teach that statues and pictures are not in themselves fit objects of worship, lest the influence produced by these material objects on the minds of the more ignorant and dull-minded should be lost, and morality should suffer.

It is because of such considerations as these, because to the great mass of men religious beliefs and practices are necessary which more advanced minds reject, that the religions of to-day, even those which seem purest and best, retain ceremonial observances belonging to times when men worshipped either natural objects, or the powers of nature. Our morning and evening services, our weekly observances, our sacraments, our ceremonies, all come to us from nature-worshipping religions. That doctrine, even, which may be regarded as the very soul of Christianity, the idea of sacrifice, shows itself in the Jewish religion as essentially derived from the practice of sacrificing to the heavenly bodies. Not one of all the sacrificial observances of the Jews, but tells us by its very nature, of its origin *as a ceremonial* in the worship of sun, and moon, and stars. The Feast of the Passover itself corresponded with the Egyptian Feast of the Sun's Passover, his transit across the equator from the gloomy winter depths into which he had descended, to the glory and power of the summer half of his career. So did the enforced gloom of the Fast of Tabernacles (when not to fast was to incur death by stoning) correspond with the mourning among Sabaistic nations as the sun neared the season of his second passover, his transit across the equator from glory to gloom.

What men constantly seem to overlook in urging such objections is that they are not needed where they would apply, and that where they are actually applied they have no existence.

Science certainly teaches a special religion—special in form though general in character. Some have indeed advanced this as an objection against scientific teaching, not because it seemed opposed to religion but because of its con-

structive religious tendencies, not because they thought science threatened to be irreligious but because they were disposed to fear lest it should become religious. But the religious teachings of science can do neither harm nor good to those who do not care for science; and for those who do care for science, who regard the study of the universe as certain to be profitable for doctrine, for training, and for encouragement in good works, the imagined danger has no existence. The question, What are those to do who, being ignorant and unscientific, cannot be moved by the mystery and harmony of the universe? is assuredly a most idle one; seeing that those who are not thus moved to awe and to obedience are also not turned away from that which already moves them to awe and reverence and dutiful service.

It is no mere theory that the change from the comparatively simple and impressive observances of sun-worshippers, to a ceremonial which while similar in outward seeming was carefully freed from all actual worship of the heavenly bodies, would be felt by the more ignorant as a loss. We know that the change *was* felt in that way. We know that for a long time the Jewish people failed to recognise how their religion had been purified when they were taught to regard those ceremonies which still outwardly related to the sun and moon and stars as merely symbolical, when they were enjoined to worship no longer the orbs of heaven but the Power from whom all things proceed. Again and again the people sought to return to nature worship. Again and again they showed their fears lest the powers of nature should be offended if no longer receiving their customary offerings, and no longer addressed as of old in prayer.

What would be thought if one were to say to the master who is training a child for the time when it must put away childish things?—"Forbear! the restraints which affect your conduct, the thoughts by which you guide your own life, have no existence for that child; you cannot trust him to act rightly without the control of others; to teach him that he must hereafter be a rule unto himself, is to deprive him of respect for that which alone can really influence his conduct." Absurd as such an argument would be it would not be more absurd than the objection raised against science, in its relation to conduct and religion, that what it teaches would afford no adequate guide for the conduct, would give no adequate impulse to the emotions, of those who as yet have not mastered the lessons taught by science or have not even heard of them.

But to tell men who *have* learned those lessons that they cannot be moved to religious emotions by the sense of unknowable uninterpretable power, that they find no strength or guidance in the discharge of life's duties in the recognition of the universal presence of law and the unending influence of every act on the happiness of self and of others, is to assert what every student of science knows to be false.

What then is the object, readers may ask, of studying the religion of science, which for those who hold it needs no defence, while those who hold it not are for the present at least in no need of it, or even better without it? My object is *this*,—To show all men that they can enter fearlessly on the study of science, assured that they can never lose thereby what is essential to their happiness and peace; and to show those who do *not* care to enter on scientific studies, that their fellow men who in ever-increasing numbers follow science are not therefore devoid of religious aspirations, of religious hopes, or of religious responsibilities.

## THE DISPERSION OF SEEDS.

By Grant Allen.

PLANTS as a class differ in nothing more conspicuously from animals than in their sedentary habits and their comparative want of locomotive power. Few among them are given to gadding about casually. Of course, there *are* locomotive plants, just as there are, *per contra*, fixed and immovable animals, which settle down in life once for all, and never again set out upon their travels—such as the oyster, the acorn barnacle, the sea-anemone, and the coral polypes. Still, viewing the two great divisions of life broadly as a whole, it is quite certain that most of us look upon animals generally as moving bodies, and upon plants generally as absolutely rooted and motionless things. It was not always so, to be sure. In the beginning, there is reason to believe, all living creatures alike, whether animal or vegetable, swam freely about in the primæval ocean; and to this day the vast majority of the lower aquatic plants begin their lives at least, if they do not also finish them, as perfectly locomotive or floating organisms. Terrestrial plants, however, as, for example, the oak and the cedar of Lebanon, are, as a rule, tolerably firmly fixed in the soil beneath them. Once a plant of this class has taken root, it may be said to have chosen its place in life; and thenceforth it seldom goes forth upon the world, but remains quietly vegetating at home, unconscious in any way of the wider ranges of earth beyond it.

This very sedentary nature of the plant kind renders necessary all sorts of curious devices and plans, on the part of parents, to secure the proper start in life for their young seedlings. Or rather, to put it with stricter biological correctness, it gives an extra chance in the struggle for existence to all those accidental variations which happen to tell at all in the direction of better and more perfect dispersion. For, in the first place, if the seeds always fell just below the parent plant, they would necessarily be overshadowed and darkened by its foliage and branches; and since light is almost to the vegetable world what food and water are to animals, this consideration alone would help largely to account for the immense number of curious devices we actually find in nature around us for the due dispersion of seeds far away from the mother organism. Then, again, the young seedlings, if all casually dropped side by side upon the ground together, would choke one another by their mere frequency, a result which really does arise, to a greater or less degree, in the case of almost all the smaller annuals. But, thirdly, we have also to take into consideration the necessity for a rotation of crops, now so perfectly understood by farmers, and understood long before in her practical unconscious fashion by mother nature. Certain plants rapidly exhaust the soil of certain needful mineral constituents, so that after they have grown upon the same spot for a given length of time together, they become dwarf and sickly, and at last fail to extract from the impoverished mould a living on any terms. Hence it is a prior necessity that the seeds of all such plants should be provided with some efficient means of wider dissemination, so that they may be able to migrate from time to time to new situations, on pain of total and immediate extinction for the whole genus. Only those plants finally survive in the ceaseless warfare for life, which are thus enabled by some lucky accident to accommodate themselves to the

stern logic of their own particular and immovable environment.

As a matter of fact, many of the smaller and simpler annuals do merely drop their seeds just beneath the parent plant, and don't suffer much in the long run from the resulting consequences. Some of them are so small, and their roots spread such a very little way in the earth, that the seed can hardly drop out of the capsule without finding a decently-fit position in life. Others grow upon banks or slopes, where the mere lie of the ground enables them to get a fresh foothold—a condition very well exemplified in plants like the wallflower and the ordinary weeds of our cliffs and precipices. In such cases, the chapter of accidents alone suffices to carry away a sufficient number of seeds for the due dispersion and survival of the species. Mr. A. R. Wallace has well noted, however, that in instances of this sort the seeds are usually small and relatively numerous; a great many supernumerary young are produced, out of all which only one or two on an average arrive at maturity. Compare this with the parallel instance of fish among the vertebrates, where sometimes, as with the cod, no less than three million eggs are spawned annually by each female, for the final average production of a single pair of adult codfish.

The first advance from this simplest mode of dropping seeds to take their chance upon the ground beneath is seen in a few plants like our common mouse-ear chickweed, which has the capsule cocked up a little at the end, and opening with small teeth, so as to prevent the seeds from falling out except during a rather high wind. The wind then jerks them out forcibly, and necessarily carries them to some slight distance from the mother-plant. I have very little doubt that almost all the capsules which open at the top only with distinct teeth have been developed for this very purpose, and that they mark an incipient advance from the lower and weedier to the higher and more dominant members of their respective families. For example, in this very same chickweed family, our common chickweed, a plant often self-fertilised, and extremely low in type, has capsules which generally open to the very base, allowing the seeds merely to drop out, hap-hazard, anyhow; while on the other hand the large, handsome, and highly-developed red campion, with its elaborate arrangements for insect-fertilisation, and its division of the sexes on distinct plants, has also a capsule shaped something like an ordinary water-bottle, narrowed at the top, and opening in ten short teeth, so that the seeds can only be shaken out by a high wind, which, of course, carries them away to a considerable distance. The same sort of progressive advance can be traced in many families, from the very simplest to the highest forms.

The yellow-rattle, which grows as a common parasite on the roots of grasses in English meadows affords us an admirable transitional type between these merely casual wind-dispersed seeds and those in which the most advanced devices for wind-dispersion have become fixed and settled by natural selection. Its big inflated capsules are filled with light and flattened seeds, which shake noisily in a gentle breeze, and so have gained for the plant its vernacular name from village children. Sometimes these seeds are distinctly winged, but sometimes they are only flat and thin. In either case, the wind shakes them at last out of the papery capsule, and carries them along a couple of yards or so from their original position before letting them drop upon the soil beneath. Devices like these lead up insensibly to more developed plans, such as that of the maple-tree, where the entire fruit, with the seed inside it, is borne on the breeze by a large expanded membranous wing, so placed that it rotates slowly like a parachute as it falls through the air, and thus almost certainly ensures the wind catching it before it finally alights from its aërial voyage. Every amateur gardener must have observed how very effectual is this means of dispersion possessed by the maple tribe; for young sycamore trees are among the very commonest and most persistent weeds in suburban gardens, even though there may not be an adult sycamore anywhere in sight within a quarter of a mile of the spot where the hardy seedlings are found rooting themselves. Much the same sort of plan is also pursued by the elm, the ash, the pine, and the linden; indeed, the necessity for remote dispersion is, of course, far more obvious in the case of large trees than of any other group of plants, both because such giants of the vegetable world need more space for their roots to grow in, and because the branches of the mother tree more completely overshadow, stunt, and starve the struggling seedlings than in the instance of any smaller and less spreading species.

Still more advanced is the method of dispersion by feathery hairs, such as those of the wild English clematis, the seed of the willow, and the ripe carpels of the pasque-flower anemone. In the red valerian of our cottage-gardens, now self-sown on many west-country cliffs, the calyx slowly unrolls, after flowering, into a feathery crown, which caps the fruit, and enables it to be lightly borne about in every direction by the autumn breezes. The thistles, dandelions, and many other plants of the composite family carry the same provision yet a step further, for here the otherwise functionless calyx has assumed a new use as a kite or parachute, and forms the familiar down which enables the tiny seed-like fruits to float freely through the surrounding air. It is curious to note, however, that some low-growing composites, such as the daisy, assuming a thoroughly weedy habit, and supplied with vast quantities of separate fruits, have found it suit them better to dispense with this special means of aërial dispersion, and seem to trust, like many other degenerate plants, entirely to accident for dissemination.

Animals play so large a part in the fertilisation of flowers that we might naturally expect to find them filling a considerable place also in the dispersion of seeds. And this expectation is fully realised, for an immense number of plants owe their dissemination almost entirely to the good services of birds or mammals, in some cases voluntarily rendered, and in other cases involuntarily. That fruits and berries are so dispersed has long been a familiar fact to naturalists. The bright colour of the pulpy exterior attracts the birds, just as the petals of flowers attract bees and butterflies. The sugary juices and pleasant flavours answer exactly to the honey and perfume. These things cause the fruit as a whole to be eagerly sought and greedily devoured. On the other hand, the actual seed itself is usually enclosed in a hard and indigestible stony covering, or is otherwise protected from the beaks and gizzards of its treacherous friends. In this manner, the sloes, haws, strawberries, and blackberries are reproduced from generation to generation by the kindly offices of our native birds.

The devices for making animals involuntarily act the part of seed-sowers to the enterprising plant, are no less marked and interesting in their own way. Cleavers or goose-grass, the "run-the-hedge" of country children, has its twin fruit covered with an immense number of tiny hooked prickles, which get entangled in the wool of

sheep, or fastened to the legs of passing cows and horses. Being rubbed off by the discontented bearer on the next bush or hedge, often enough in a nice little cake of fruitful manure, the fortunate seeds take root at once under fresh and favourable circumstances, and often prove the precursors of a strong and healthy future stock. In hound's-tongue, the adhesive little burrs cling even more tightly to the passer-by, and are liable to be carried to still greater distances from the parent plant. The burr of the burdock consists of a whole head of flowers and fruits, which separates readily from the dry stalk, and fastens itself firmly to the hair or wool by means of its very hooked and clinging bracts. In tropical countries these bids for cheap carriage are still more frequent and troublesome than in our own poor little northern flora.

Some very advanced plants go so far as actually to disseminate their own seeds, or even to bury them bodily under ground. There is a common little English weed, the wall-cress, abundant everywhere on banks and in dry places, whose pods, especially when touched or shaken, roll up elastically, and scatter the tiny, bullet-like seeds to a distance of some six or seven feet by their powerful impulse. The capsules of the balsam similarly eject the seeds for a considerable length, and everybody must have noticed the crackling of the gorse-pods on bright autumn days, by which means the small beans within are thrown out forcibly with no little violence among the surrounding thickets. The squirting cucumber of Southern Europe, if lightly touched when quite ripe, breaks off at the stalk with a slight bang, and scatters its seeds and their surrounding pulp not infrequently in the face and eyes of the too-intrusive visitor. More remarkable still is the plan adopted by the subterranean clover, in which the undeveloped flowers in the centre of each head act as a sort of insinuating corkscrew, and, screwing slowly downwards, bury the pods of the fertile blossoms at last far beneath the surface of the close-cropped turf. In the familiar pea-nut of American youth the same cunning device is carried to a still further pitch of perfection with Yankee ingenuity; for the so-called nuts are really subterranean pods, produced by self-fertilisation upon simple bud-like underground flowers, and therefore, as it were, ante-natally buried. In these last cases the object is, no doubt, rather to escape the notice of enemies than to ensure dissemination in the ordinary sense, for mere purposes of rotation or dispersal.

Last of all, we have to remember that water aids largely in the dispersion of seeds, especially for marshy or seashore plants. Many fruits of fresh-water kinds have a smooth rind with an oily juice, which the water cannot penetrate, and they are carried down by the current from one spot to another, a point particularly important to shallow water or swampy species, as the course of the stream is constantly altering, and the ponds and back-waters are continually drying up in the hot weather. The sea has transported the cocoa-nut, with its thick shell and hairy covering, almost impervious to salt water, among all the coral reefs and lagoons of the Pacific. Other plants have been carried by the Gulf Stream from the shores of America to the lakes and tarns of the Hebrides, or from the islets of Bermuda to the marshes of the west coast of Ireland. It is probable, indeed, that while wind is on the small scale the great disperser and carrier of seeds, the sea has been in a wider fashion the chief disseminator of the more generally-dispersed groups over the face of the earth. Only those plants whose seed can stand long immersion in salt water are liable to be found in any great numbers over wide tracts of land dissevered by the ocean, or on newly-raised islets in the midst of the sea.

## COAL.

By W. Mattieu Williams.

### I.—WHERE COAL IS FOUND AND WHEN PRODUCED.

I HAVE been very rude on more than one occasion during my lifetime. I have said, "Sir, your education as an Englishman has been shamefully neglected," to men who read Homer in the original for seaside recreation, who know all the irregular Greek verbs, who can scan, construe, and write Latin verses; even to men who manipulate the differential and integral calculus as glibly as a banker's clerk can sum up money columns, and who have been dragged to the very brink of cerebral meningitis, by dons, tutors, coaches, and examiners. I have perpetrated this rudeness finding that these Englishmen knew little or nothing about the Englishman's peculiar mineral, coal. In some cases my rudeness was applied to men whose incomes were largely derived from royalties on coal that was then in the course of working on their own estates.

An amusing example of this common habit of neglecting common homely things was afforded by a visit of the Earl of Dudley (then Lord Ward) to the Birmingham and Midland Institute in our early days, when we were located in the humble premises of the old Philosophical Society in Cannon-street. I was showing him the collection of local fossils in the museum of the Society. The massive lumps of coral especially interested him. "Very fine, very choice; brought from the tropics, of course," he exclaimed. When I told him that they came, not from tropical seas, but from the rocks upon which Dudley Castle is built, and that the Dudley limestone which yielded so large a revenue to his lordship was chiefly composed of these corals, he eyed me very queerly and suspiciously; but when at last he found that I was quite in earnest, and was backed by a clerical friend who came with him, he was hugely amused at himself, and resolved to give more attention to Dudley corals than he had done hitherto.

Although it may not be the case that *all* the readers of Knowledge are receiving royalties from coal-seams on their private estates, there are certainly none of them who are not receiving large benefits from the coal which is raised and variously worked on the common estate of the British nation. This is even the case with the colonists and foreigners who read this magazine. All, therefore, should follow the sensible example of Lord Ward, and resolve to become better acquainted with so important an element of their national patrimony.

The object of this series of papers is to supply that kind and amount of information concerning our specially English mineral fuel which every intelligent Englishman should possess.

Such information includes a general elementary acquaintance with the geological relations of coal deposits and their probable origin, without struggling with recondite technical details; a general knowledge of how coal-mines are sunk and worked, and of the social condition of the workers; and something about the physics and chemistry of coal itself, and the wonderful multitude of useful and curious products which are now obtained by the distillation of coal and the chemical transformations of the distillates.

At the outset it will be well to sweep aside a widely-spread illusion concerning the geological occurrence of coal. Our ordinary coal, broadly speaking, belongs to one geological period or series of rocks, and this has accordingly

been named the "carboniferous" epoch or group. In like manner we have designated the particular deposits of that great period in which the coal chiefly abounds as "the coal measures." Such names occurring in geological books and on geological charts, and commonly quoted therefrom, naturally suggest the conclusion that these are the only coal-bearing strata. Another source of this popular inference has doubtless been supplied by the speculations of some geologists concerning the state of the world during the carboniferous epoch, speculations involving the idea that once upon a time the whole atmosphere of the earth was abnormally charged with carbonic acid and aqueous vapour; that vegetation just then was exaggerated in its luxuriance; that this period followed a volcanic era which supplied the excess of carbonic acid by eruptions of that gas from its craters, the formation of the gas being due to the roasting of limestone rocks and the combination of the lime with the silicic acid of fused siliceous rocks.

Going back to the article on Coal in the third edition of the "Encyclopædia Britannica," for instance, I find the following:—"The amazing irregularities, gaps, and breaks (says Mr. Magellan) of the strata of coals, and of other fossil substances, evince that this globe has undergone the most violent convulsions, by which its parts have been broken, detached, and overturned in various ways, burying large tracts of their upper surfaces, with all the animal and vegetable productions there existing at the time of those horrible catastrophes, whose epoch far precedes all human records."

This passage is curious and instructive; it expresses in a few words the prevailing geology of the period when Sir Charles Lyell received his first geological teaching, and which he devoted the greater part of his life's work to correcting. He and his successors have shown us that the facts revealed by careful examination of the earth's structure may be explained consistently without the invention of any "horrible catastrophes," or periods of extravagantly violent volcanic convulsions, or deluges, or periods of atmospheric floods of carbonic acid, or any other sensational proceedings of nature far exceeding in volume those now in progress. Allowing a sufficient time for their operation, the forces that are now modifying the crust and surface of the earth are capable of doing all that has been done during the formation of the earth's crust, with no greater or more frequent outbreaks of exceptional violence than those which occasionally disturb the present epoch.

In the eighth edition of the above-quoted national work (that immediately preceding the new edition now in progress), the following geological information is given. "Coal is found in those strata designated the secondary formation, or coal measures, and in seams varying from an inch to forty feet." No mention is made, or indication given, of the existence of coal in any other geological region, thus justifying the commonly-accepted notion that coal is an exceptional deposit, formed during an era when all the world was undergoing an exceptional spasm of exuberant vegetation.

We now know that deposits of some kind of coal exist in every great group of rocks that contain any vestiges of life, and that coal is in course of deposition at the present moment.

The earliest deposit takes the form of graphite, or "black-lead," which contains no lead at all, and is not a "carburet of iron," as stated in many books, but is nearly pure carbon.

This, the softest of solids (I am not speaking of pulpy softness due to semi-fluidity)—so soft that it can scratch no other solid and is scratchable by nearly all, and is filed away by the asperities of the smoothest writing-paper—has the same composition as the hardest of all solids, that which scratches every other solid and is scratchable by none—the diamond. Graphite is found even in the hypozoic rocks, or those lower down or more ancient than any that bear the remains of organic beings. Much has been written concerning the origin of graphite—upon the question whether it is primary and purely mineral carbon, or whether it is an altered vegetable product. I must not be tempted to discuss this at any length, but will simply quote the conclusions of a high authority.

Bischof ("Elements of Chemical and Physical Geology") says, "The geologists who ascribe to the earth an igneous origin, can adopt no other view than that all the carbon upon and in the earth is of secondary origin, and therefore was not present at the period of creation; for the reducing agent of the iron ores would not have remained in contact with peroxide of iron and other oxides in the state of igneous fusion without being converted into carbonic acid and carbonic oxide gases, thus causing the reduction of the oxides. Since the entire group of unstratified crystalline rocks, which, according to the plutonists, have been ejected from beneath, contain in their masses no carbon, this fact must lead them to the conviction that this substance cannot be an original formation."

Bischof is by no means alone in concluding that all isolated carbon found in the earth can "only be regarded as a product of decomposition of carbonic acid, and it is the vegetable kingdom which yielded and still yields this product." The fact that we find such carbon lower down or earlier than any remains of animal life does not disturb this conclusion. Vegetable matter being the primary food of animals, they must have been preceded by vegetables, and probably by immeasurable ages of vegetable evolution, or of zoophyte (animal-plant) evolution, and these lower rocks which entombed the remains of the links of life connecting plant with animal, having been subjected to the metamorphic agencies of crushing pressure and the high temperature that still exists at great depths, could not preserve the forms, though they may have retained the one non-volatile solid element of these primordial living things. Graphite corresponds to this.

*Anthracite*, as Bischof says, "occupies an intermediate position between coal and graphite," and is undoubtedly of vegetable origin. It is both geologically and chemically intermediate, being frequently found in more ancient rocks than those which bear bituminous coal. This, however, is not universally the case; anthracite also occurs in the same formations as bituminous coal, and is even continuous with it, as will be explained hereafter.

Our richest seams of coal occur in the upper part of the carboniferous group in the "coal measures" above-named. The appended table, copied from Mr. Morris's chart, indicates their position.

The table includes only the Paleozoic rocks where the most ancient or primary traces of life are found. Below them are *Hypozoic* or *Metamorphic* rocks, in which are found no other traces of life than the ambiguous graphite, and below these the granite; above them, a vast world of later growth.

So completely does the coal disappear from the majority of our coal-fields when we go below the upper series of the carboniferous rocks, that the millstone grit has received the name of the "Farewell Rock," experience

having taught the majority of those who bore for coal to bid farewell to their prospects of finding it when this is reached. Nevertheless, in other places good workable coal is found below this, in the mountain limestone and limestone shales, such as the Yoredale rocks and Scaw limestone of the great northern coal-fields of Durham and Northumberland, and still more productively in Scotland.

It would be entering too much into detail to tabulate and specify particularly where coal is found in the later geological ages. I may simply name the oolitic coal field of Whitby in Yorkshire, as one of our British exceptions to the occurrence of coal-seams only in the coal measures. The coal-fields of Richmond, Virginia, is of the same date. Many others of the most important coal-seams of the world, violate the traditions of the British collier by occurring still higher, in the Wealden, the Cretaceous, and higher still in nearly every great series of the Tertiary rocks.

If we fail to find any coal in the Wealden, Cretaceous, and Tertiary deposits south of London, it is not because the existence of coal is there forbidden by any general geological law, but on account of local conditions that prevailed when these rocks were deposited. There are great forests in some parts of the world at the present moment, and a lack of such forests in other parts, even in corresponding latitudes. There are coal-seams now in course of formation in certain limited regions (as I shall describe in my next), but by no means everywhere. This appears to have been ever the case since vegetation began to flourish on the earth.

| | | |
|---|---|---|
| PALÆOZOIC OR PRIMARY. | PERMIAN OR MAGNESIAN LIMESTONE. | Red sand and marl.<br>Magnesian limestone.<br>Marl slate.<br>Lower red sandstone. |
| | CARBONIFEROUS. | *Coal measures.*<br>Millstone grit.<br>Mountain limestone.<br>Limestone shales. |
| | DEVONIAN OR OLD RED SANDSTONE. | Upper Devonian.<br>Middle Devonian.<br>Lower Devonian and Tilestones. |
| | UPPER SILURIAN. | Ludlow and Aymestry rocks.<br>Wenlock rocks.<br>Woolhope series. |
| | MIDDLE SILURIAN. | Llandovery and May Hill rocks. |
| | LOWER SILURIAN. | Caradoc and Bala rocks.<br>Llandeilo rocks.<br>Lingula flags and Tremadoc beds. |
| | CAMBRIAN..... | Llongmynd and Cambrian rocks. |
| | LAURENTIAN..... | Laurentian rocks. |

## MR. HERBERT SPENCER ON CHURCH AND STATE.

JUST now, when the question of Church and State in England is somewhat prominently before the public, the philosophical discussion of the general question by Mr. Herbert Spencer, in the just-issued sixth part of the "Principles of Sociology" (Ecclesiastical Institution), has special interest,—though it has not any real bearing on the particular problem about which party politics are disturbed. Mr. Spencer manifestly does not consider the Disendowment of the Established Church a matter of vital moment. He does not even mention it in his chapter on Church and State.

The influence of the Church within a State began when men began to believe in the necessity of propitiating the ancestral dead, learning their wishes, and carrying them out. Whether Mr. Spencer is right in giving to the belief in ancestral ghosts so marked a precedence as he does over the belief in the presence of will and power in various natural objects (in the near at first, and afterwards in those more remote) may possibly be questioned, even in full view of the array of facts he has for evidence. That the worship of dead ancestors long preceded the worship of nature, of the heavenly bodies, of animals, and so forth, is, however, certain—as Schlegel discovered in dealing with Hindoo mythology. And it is equally certain that the first priests, in all nations which have left any records of ancient beliefs, were employed in ministrations for the propitiation of the spirits of dead chiefs: the first altars were mausoleums. Thus we can understand how in those days the kingly and the priestly power would be united in the same person. The secular rule was in the beginning little more than the instrument of the sacred rule,—and, as Mr. Spencer remarks, "where the normal rule has not been broken, the organisations for sacred rule and for practical rule remain practically blended.

When pantheism took the place of ancestor worship, or when almost from the beginning pantheism and ancestor worship were parts of the same primeval system, the priest's duty would still be to propitiate, to interpret, to intercede with, and in some cases even to influence the departed rulers of the people. Thus the power of the priesthood would be immense, their influence wide. We are told that in Egypt, where those great tombs the pyramids, with their astronomical characteristics, tell us of a time when ancestor worship was merging into nature worship, "the priesthood took a prominent part in everything . . . . nothing was beyond their jurisdiction; the king himself was subject to the laws established for his conduct, and even for his mode of living." And it was the same in other ancient nations, while they remained worshippers of their ancestors or of natural objects. "That this blending of Church and State is not limited," says Mr. Spencer, "to societies in which the gods are apotheosised rulers more or less ancient, but is found also in cults which are not indigenous, and that it continues as long as religious beliefs are accepted without criticism, we are shown by the history of mediæval Europe.

Among the causes of the maintenance and growth of Church power in the State, Mr. Spencer cites:—

1. The claim of the priest to give a sanction to the authority of the civil ruler.

2. The influence which the priest is supposed to exert over supernatural beings, by his prayers and invocations,—alike for evil as for good.

3. The assumed power to grant or refuse forgiveness of sins.

4. The attainment of more knowledge than other classes possess,—and in particular the art of writing. Under this head may also be included the circumstance that the civil rulers from the highest downwards, in the earlier times we are considering, receive their teaching from the priesthood.

5. The power resulting from the accumulation of property,—beginning with the accumulation of money paid to them as exorcisers and diviners, "progressing to fees in kind to sacrificing priests, and growing by-and-by into gifts made to temples and bribes to their officials, wealth everywhere tends to flow to the ecclesiastical organisation."

With such powers, natural and supernatural, it might

XUM

be thought that in no case could the Church ever become subordinate to the State; that Nonconformity could not even begin to be, far less grow into rivalry with an established Church; and that even if Nonconformity did spring into existence the Church could always maintain superiority, if not supremacy.

In many countries the Church *has* proved irresistible. There have been civilisations which have passed through all the stages of their development to the close of their career, with the Church always indissolubly associated with the State, and always the supreme power. Greece perhaps is the only example among ancient races of a nation where the priestly power did not attain great development.

Mr. Spencer attributes the change—where it is effected—from an original predominance of the spiritual power over the temporal power until ultimately the temporal power bears sway, to that cause which we have found in other cases chiefly operative in determining the higher types of social organisation—the development of industrialism, the modification of Nature caused by substitution of a life carried on under voluntary co-operation for a life carried on under compulsory co-operation—the transition from a social state in which obedience to authority is the supreme virtue, to a social state in which it is a virtue to resist authority when it transgresses prescribed limits. He remarks very justly that the character fostered by the discipline arising from the daily habit of insisting on self-claims while respecting the claims of others, does not favour unqualified submission either to the political head and his laws, or to the ecclesiastical head and his dogmas. Moreover to the moral change must be added the intellectual—"also directly resulting from the development of industrial life—that spreading knowledge of natural causation which conflicts with and gradually weakens belief in supernatural causation."

It is strange for us in England—fortunate here above all other nations except our English-speaking kindred across the Atlantic—to look back on the past condition of our race in this respect. From 1373 until Henry VIII., in 1530, promoted Sir Thomas More, not one of our chancellors, as Blackstone notes in his "Commentaries" was a lawyer,—most of them were ecclesiastics, the rest courtiers. From the year 1592, when Serjeant Puckering was made Lord Keeper, the Chancellor was always a lawyer until 1625, when in the evil Stuart times the Seal was intrusted to Williams, afterwards Bishop of Lincoln.

We may be permitted to regard the loss of that past influence by the Church as a gain, when we note that, as Buckle truly points out, the history of England in the sixteenth and seventeenth centuries shows the power and reputation of the Church "almost always bearing an inverse ratio to the power and reputation of the country at large; rapidly sinking under the brilliant and orderly administration of Elizabeth, and as rapidly rising under the disgraceful and disorderly Governments of the first English Stuarts."

The loss of power by the Church since the extravagant pretensions of the hierarchy in Stuart days have been resigned, has not been inconsistent with a growth of reputation and even of real influence. For though in parts of England where the industrial type of life and organisation predominate, the influence of the Church has naturally diminished, yet among rural populations it has probably increased—with increase of dignity of life and earnestness of purpose among the priesthood of the Established Church.

## MOVEMENTS OF THE PLANETS.

By Richard A. Proctor.

THE chart of planetary orbits indicates the movements of the four giant planets during the four next years. The movements of the earth month by month along her small orbit, the third in order of distance from the sun, are also indicated. It will be seen that Neptune is in opposition in November, not only this year (November 16, at 8 a.m.), but next year (November 18, at 7 p.m.), and during several years past and to come. Uranus was in opposition last on March 21, at 8 a.m., and will next be in opposition on March 26, at 10 a.m., and again on March 31, 1887, after which his oppositions for several years will occur in April. Saturn will be in opposition on December 26, at 11 a.m., and will not be in opposition again till January, 1887. (Astrologers, please find some meaning in the circumstance that the whole of 1886 will pass—the first time such a thing has happened in many years—without any opposition of Saturn.) Jupiter was last in opposition on Feb. 19, at 8 a.m., and will again be in opposition on March 21, 1886. If the student will recall that the sun himself is exaggerated in size in the chart, small though he looks there, so that even Jupiter would be far less than the least of the dots set round the orbits, he will probably appreciate the enormous risk to which our solar system has been exposed through the passage of their perihelia by the giant planets. It is easy to draw the orbits and the planets themselves in such a way as to make the risk look terrible; but rightly pictured the solar system is seen to be safe enough from this particular form of danger.

Simple though the illustrative chart is, the planetary movements have never before been presented with the same degree of accuracy in a chart of the kind.

The path of Saturn from conjunction, when he was of course invisible, in 1885 (June 18) to conjunction again in 1886 (July 4) is shown in the smaller figure. No other planet will be in opposition this quarter, except Neptune, whose small loop seemed scarcely worth depicting.

It will be seen that during the first quarter of 1886 Saturn will pass very close to the third magnitude stars $\mu$ and $\eta$ Geminorum.

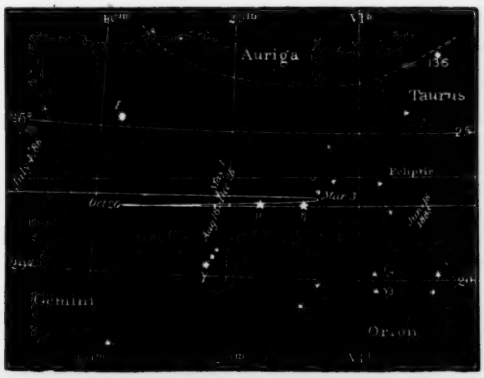
The small map illustrates one use of my zodiacal maps which is I think worth noticing; the places of the stars have been pricked off from the proper zodiacal chart, and then the path of the planet marked in from the places given in the "Nautical Almanac."*

Next month we propose to give the movements of the four inferior planets, Mercury, Venus, Earth, and Mars, from month to month, during 1886, with suitable explanatory diagrams.

The opposition of Mars in 1886 will also be illustrated next month.

We hope soon to start a series of monthly observations,—that is observations made during a month preceding the time of publication,—by our esteemed contributor "A Fellow of the Royal Astronomical Society."

* I have thought it might be useful to republish these twenty four charts, and have included them in a work now ready for publication, "The Seasons Pictured," in forty-eight sun-views of the earth, twenty-four zodiacal maps, and other drawings.




**Path of Saturn, from conjunction in June, 1885, to conjunction in July, 1886.**

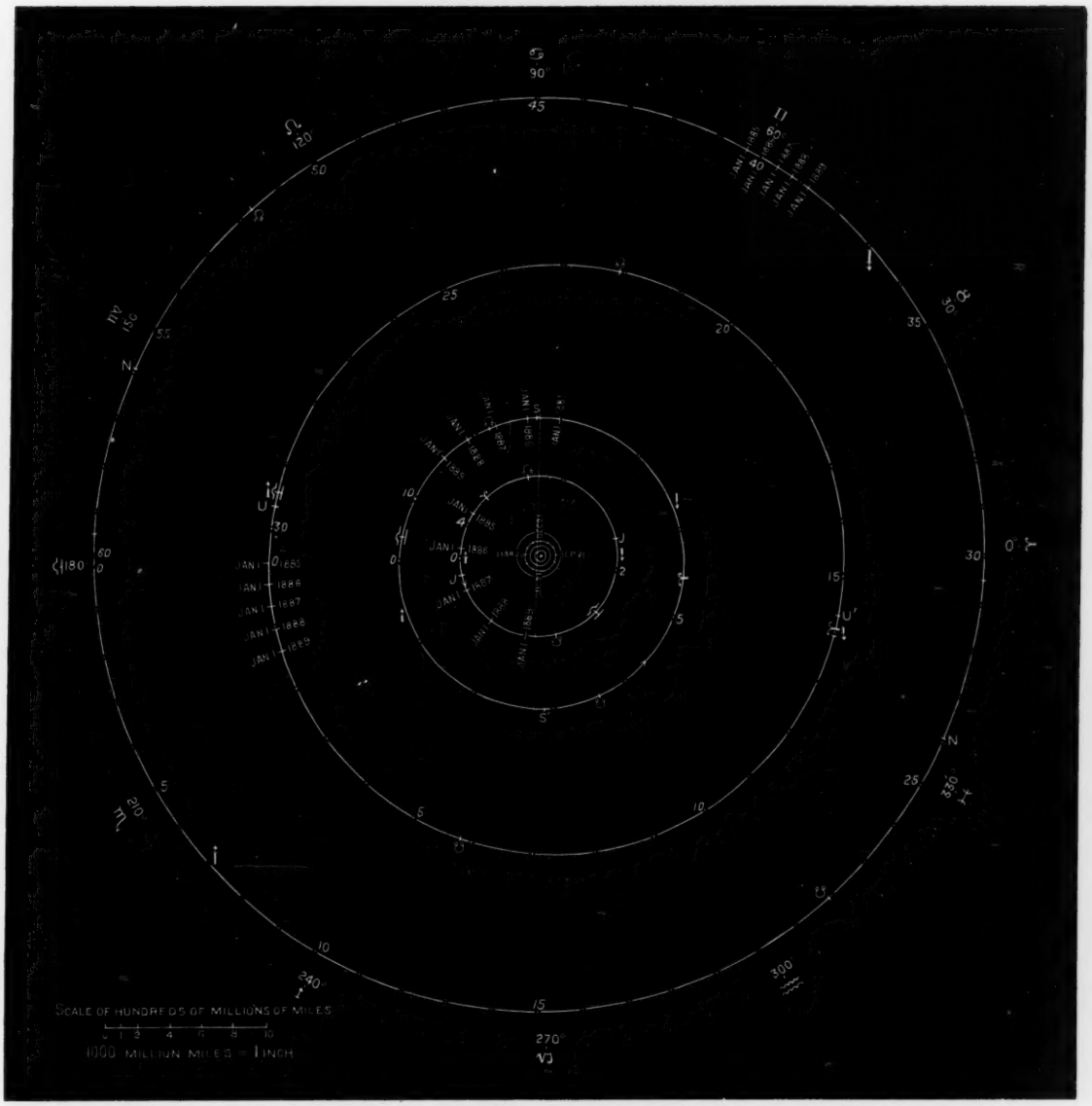
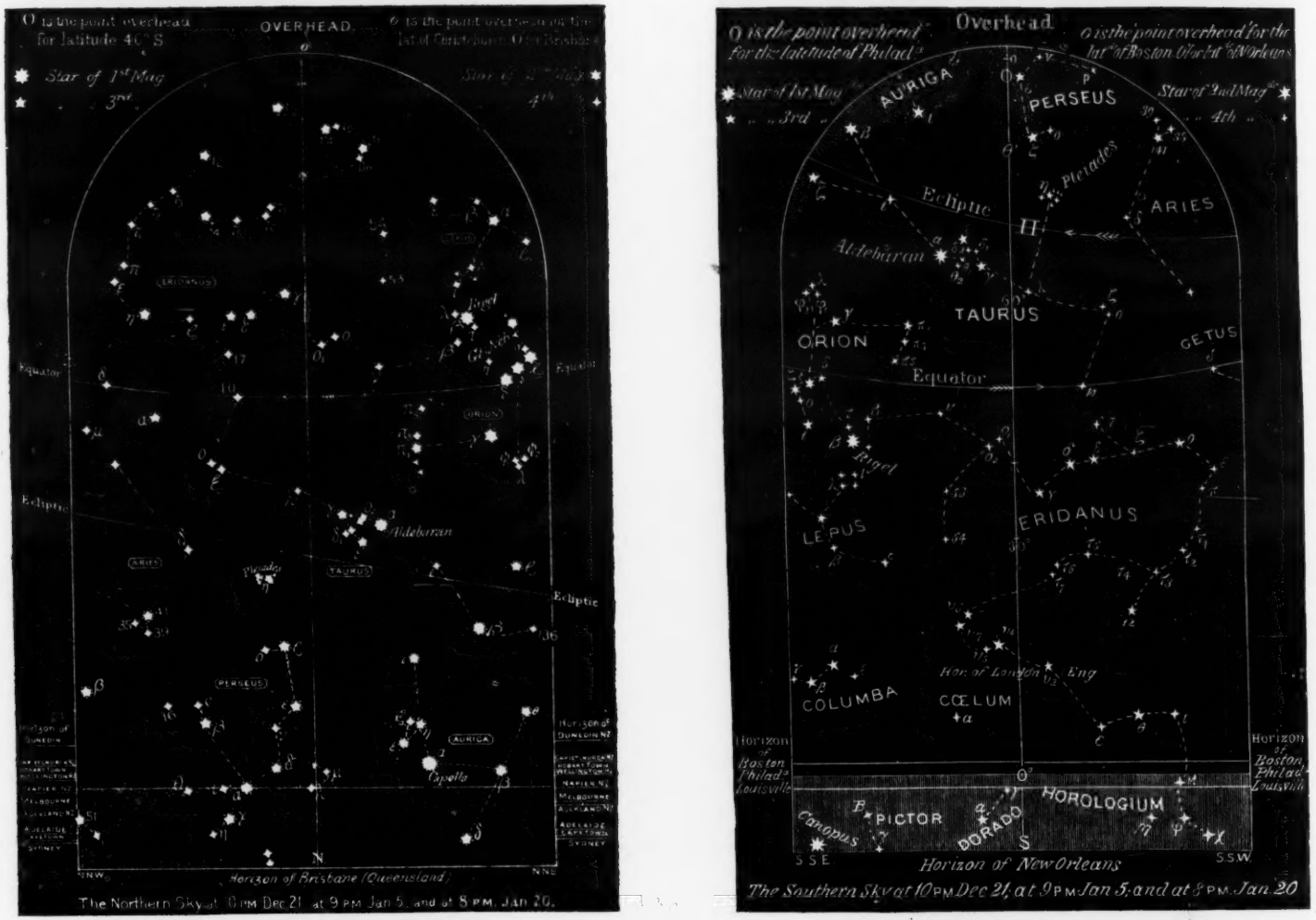



**Chart of the Solar System, showing the movements of the four outer planets from January 1, 1885, to January 1, 1889.**

for Comets see page 54.

XUM

XUM




**The Stars seen towards the north from southern latitudes, and towards the south from northern latitudes, at 10 P.M. December 21, at 9 P.M. January 5, and at 8 P.M. January 20.**

## THE SKIES OF THE SOUTHERN HEMISPHERE.

By Richard A. Proctor.

I HAVE planned a work for the Southern Hemisphere akin to my "Easy Star Lessons" (drawn up of course for the northern hemisphere). But the small encouragement which Australian booksellers give to the idea, leads me to believe that for the present I shall have to be content with a series similar to my "Star Primer" now just ready for publication, in which the stars are shown fortnight by fortnight in the simplest possible way, at their true relative height above the horizon and also in their true direction with regard to the cardinal points. The series will commence in January with the map for the southern skies in March, so that there may be due time for each map to reach the other hemisphere before the date for which it is intended.

I give this month the northern skies as seen from the latitude of various southern places mentioned on the map. With the kind consent of Messrs. Chatto & Windus, I also give for comparison the corresponding map of the set of forty-eight given in my "Easy Star Lessons." It will be seen that the greater part of the northern map is included in the southern map too, only inverted. By the northern map I mean the one for our northern hemisphere, in which the southern sky is shown; in the southern map the northern sky is given. It is singular to a northerner to see Orion upside down in the northern skies, as the map shows the Giant Hunter, and as he will be shown more fully in next month's map, presenting him due south. A John Hampden in the southern hemisphere would feel that if the stars are seen as in the northern map from our hemisphere and as in the southern map in the southern hemisphere, the starry heavens are in league with the untruthful astronomers; or he might prefer to close his eyes and decline to see the familiar northern constellations as they ought *never* to be seen on the flat-earth theory. But to the student of astronomy the change of aspect as Orion, for example, passes from the south, to the region overhead (when the observer is at the equator) to the north (when the observer has gone south)—precisely as though the earth were a globe! We shall have Hampden denouncing Orion now.

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A Message from Mars.—One of those idiots who find it amusing to invent lunar hoaxes, false sea-serpents (thereby silencing those who have seen real, but as yet unclassed, sea-creatures) great gooseberries, and so forth, has amused his leisure moments, which are probably many, in devising an account of certain signalling which appears to be going on in the planet Mars, and to which astronomers on earth are preparing to make reply. The circumstance is interesting as presenting in a new form the perplexing problem Whence had this particular form of idiocy its origin, and how did it attain its present development. The simple idiot we understand, the lunatic we can even appreciate as akin—so we are told—to the genius: but this particular kind of idiocy is not easily to be interpreted.

The Little Naps of Little Fishes.—An experiment has recently been tried at the Inventions Exhibition Aquarium by Mr. W. August Carter, with a view to discover how far fish are prone to sleep. After a close examination, he found that amongst freshwater fishes the roach, dace, gudgeon, carp, tench, minnow, and catfish sleep periodically in common with terrestrial animals. The same instincts were found to actuate marine fish, of which the following were observed to be equally influenced by somnolence, viz., the wrasse, conger eel, dory, dogfish, wrasse bass, and all species of flat fish. Mr. Carter states that, so far as he can discover, the goldfish, pike, and angler fish never sleep, but rest periodically. Desire for sleep amongst fish varies according to meteorological conditions. Fish do not necessarily select night-time for repose.

## THE STORY OF CREATION.

A PLAIN ACCOUNT OF EVOLUTION.

By Edward Clodd.

INTRODUCTORY.

Happy the man whose lot it is to know
The secrets of the earth. He hastens not
To work his fellows' hurt by unjust deeds,
But with rapt admiration contemplates
Immortal Nature's ageless harmony,
And how and when her order came to be.
Such spirits have no place for thoughts of shame.
Euripides. *Fragment*, 902.

HALF a century ago the public mind of England was agitated by the Tractarian movement, the aim of which, broadly stated, was to undo the work of the Reformation in the Established Church.

Rarely can any age take true measure of its men, or true perspective of its events, and they who watched the signs of those stormy times, deafened by the tumult, deemed that one of the world's great crises, fraught with influences and issues reaching to a far-off future, was impending.

But the Lord was not in that earthquake. Among the leaders of Puseyism there was no maker of an epoch; their movement was retrogressive, a vain endeavour to satisfy the craving of men's better selves with nutriment from musty records of a moribund past.

About the same time Charles Darwin sailed as volunteer naturalist on a five years' voyage in the *Beagle*, a ten-gun brig, commissioned to survey the shores of South America, and to circumnavigate the globe.

Few heeded the departure of that ship, none could foretell what memorable results would follow from her voyage, or know that she carried the man destined to knock the bottom cut of all the creeds, and to establish morals and religion on foundations that are independent of the shifting shibboleths of theology; in fine, to revolutionise or profoundly modify every department of human thought, and every motive to human action. But so it was. The true epoch-maker, never dreaming to what large and momentous result his work would lead, passed unheeded, on his return, to his Kentish home, there to consider the significance of the facts gathered during his voyage. The distribution of living things in South America, and markedly in their relation to those in the Galapagos Islands, a group lying five hundred miles off that continent, led Darwin to convictions regarding the mutability of species, and to a solution of the problem of their origin which, after the lapse of nearly a quarter of a century spent in the weighing of every fact and argument telling for or against his theory, was published in the famous "Origin of Species."

"Tract XC." is now remembered only for the part which it plays in Cardinal Newman's fascinating "Apologia," but the "Origin of Species" abides as the imperishable record of the most momentous advance in man's knowledge of the operations of nature since the "Principia."

The pens of many experts, ready writers withal, have enriched our scientific literature with clear and charming expositions of Darwin's theory for the benefit of a public which runs so fast that it has little time to read. But that theory, it must be borne in mind, deals only with organic evolution, *i.e.*, with the origin of the myriad species of plants and animals, and the prominence given to it makes us apt to overlook that it is only part of an all-

XUM

embracing cosmic philosophy. For whatever lies within the phenomenal, the seen or felt, and therefore within the sphere of observation, experiment, and comparison, whether galaxy which only the telescope makes known, or monad whose existence only the microscope reveals, is subject-matter of enquiry, both as to its becoming and its relation to the totality of things. It is this more general *conspectus* of the theory of Evolution which it will be the endeavour of the present series of papers to give in clear and, as far as possible, simple words.

Before passing to a detailed exposition of that theory, it is necessary to state as briefly, yet as completely as may be, the problem which, in the judgment of every scientist of repute, it has solved. This involves setting down certain general facts which every school-boy is, theoretically, supposed to know, but which people whose schooldays are long past have, practically, forgotten. That is to say, such matters as the stuff of which all things are made, its combinations and affinities; the relation, likeness, and unlikeness between the stellar and solar systems; between the earth and its fellow planets, large and small; the varied forms and conditions of past and present life, and the relation between these and the inorganic or non-living; the causes of changes now occurring, and which interpret changes that have occurred; these must, one and all, be described as constituting the question to which the answer longed-for, here and there well-nigh grasped, by many kings and prophets of science "who died without the sight," has been given to this generation.

Such statement may not be useless in itself, if it helps to create or to awaken in the mind that feeling of an underlying and indivisible unity between the remote and near, the past and present, the living and non-living, which is apt to lie dormant when things in chemical or vital relation are treated as separate, or as differing in kind. Astronomer or chemist, geologist or palœontologist, psychologist or physiologist, botanist or zoologist, we are all members one of another, and none can say to his fellow, "I have no need of thee." The astronomer captures the truant light from the stars, and the chemist, decomposing it, compels from it the secret of their structure, even the direction in which they travel. The geologist rives the strata asunder, and discloses their succession and contents; the palœontologist, disengaging the fossils imbedded in them, or altogether composing them, finds the ancestral forms of living species and the missing links in the unbroken chain of life. The psychologist may analyse and catalogue the operations of the mind, but the key to understanding them lies in the study of brain-structure and function, of which the physiologist is master; while the botanist and zoologist alike miss the significance of the phenomena of plant and animal life, if these are treated as separate departments of biology. Truly, as Emerson says, "the day of days, the great day of the feast of life, is that in which the inward eye opens to the unity in things."

Yet must we exclaim with the chorus in the "Antigone," and in these days with a deeper meaning, "Who can survey the whole field of knowledge? Who can grasp the clues, and then thread the labyrinth?" For the material is so wide-ranging and varied that in these papers only the barest outline is possible, and in dealing whether with star or species, the one must represent the whole; the individual the class. Our knowledge will, however, thereby advance from the particular to the general, and be enlarged from a mere storage of facts to an all-inclusive philosophy of things; so that although we may not escape errors of detail, we shall be saved by true apprehension of the universal. In illustration of this, we know that all mammals breathe through lungs, have four-chambered hearts, and not less than three bones supporting the tympanum or drum of the ear. Without burdening our memories with the long list of mammalia, we include in the conception "mammal" all that is common to man, ape, whale, &c., never doubting that if a new species of mammal were found it would have the foregoing features.

The matter to be described must not be confused by the intrusion of either the historical or the hypothetical. As far as lies within the writer's power, only the "things commonly believed among us," concerning which the doubting Thomases can have sight or touch, will be set down. But there can be no *detour*, no turning to the right hand or to the left, to tell what theories this or that philosopher of olden or newer time held about the heavens and the earth and the elements; neither what this or that ancient manuscript or tablet records in explanation of their origin; for to refer to such here would be to obscure their value and interest as records of theories which are now discredited, and to invest them with a false importance. Such references to obsolete speculations would be still more confusing when the mechanical explanation to be given of the general and simpler phenomena of the lifeless is extended to the special and complex phenomena of the living, and more particularly to those of the faculties and operations of mind in the lower animals and in man, the highest animal. From the moneron, a minute structureless mass of slime, to shapely man with the complex apparatus of his mental operations—without pause wherein caprice or chance could enter to disturb the sequence. But caprice and chance are not: the nebulous stuff of which the universe is the product held latent within its diffused vapours, not only the chemical elements of which the dry land and the waters are built, not only the life-germs from which the boundless varieties of plants and animals have descended, or ascended, but aught else that, through work of man for good or ill, has composed the warp and woof of this world's strange, eventful story.

Although much is, however, explained by evolution, and although no limitations can be recognised within the sphere of the phenomenal, there remains much more than is dreamt of in our philosophy unexplained, around the impenetrable marge of which imagination, and the sense of mystery that feeds it, can play. "Positive knowledge does not, and never can, fill the whole region of possible thought. At the uttermost reach of discovery there arises, and must ever arise, the question—What lies beyond?"* The whence of the nebula and its potential life remains a mystery to overawe and baffle us. The beginnings of the crystal are no less unknown and undiscoverable than the beginnings of the cell; the ultimate causes which lock the atoms of the one in angular embrace, and which quicken with pulsating life the globules of the other, lie beyond our ken, beyond the field of scientific inquiry. And if of the beginnings nothing can be known, so is it with the things themselves, and which affect us by their colour, their weight, and movement. They remain the unknown cause of sensations which are themselves, as Helmholtz says, and as Descartes said two centuries before him, only *symbols* of the objects of the external world, corresponding to them only in some such way as written characters or articulate words to the things which they denote. There is no greenness in the grass; there is no redness in the rose; there is no

* *First Principles*, p. 16 (3rd Ed.).

hardness in the diamond; that which our sensations report to consciousness as colour and hardness being the result of myriads of motions, some of which are repeated as often every second as there are seconds in thirty millions of years, motions within us and without us quite unlike one another.

Thought and emotion have their antecedents in molecular changes in the matter of the brain, and are as completely within the range of causation, and as capable of mechanical explanation as material phenomena, but of them no material qualities, as weight, occupancy of space, &c., can be predicated. Heat may be expressed in equivalent foot-pounds, light and sound and nervous transmission in measurable velocities, but these never. We cannot make the passage from chemistry to consciousness, or transform motions of nerve tissue into love, reverence, and hate.

But, to quote the author of the Book of Maccabees: "It is a foolish thing to make a long prologue, and to be short in the story itself," wherefore it is well to pass without further preface to setting forth the framework of the story, that the reader may have clearer understanding of its scope and purpose.

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## PLAN.

### Part I.—Descriptive.

I. The Universe.

Its contents:—Matter, Force, and Energy.
Distribution of Matter in space.
The Solar System and its members.
The Earth as (more or less) a representative member.
The stuff of which it is made.
1. Its inside.
2. Its outside:—
*a*. Liquid and gaseous envelopes.
*b*. Solid crust, divided into:—
1. *Unstratified* rocks; features.
2. *Stratified* rocks. Order and succession. Organic remains.

Changes to which these deposits and their contents witness:—
Agencies of change:—
1. Atmospheric.
2. Aqueous.
3. Volcanic.
4. Organic.
5. Man.

Life-forms: stuff of which all are made.
1. Plants: summary of existing species.
2. Animals: „ „ „
(Intermediate forms.)

Sun as ultimate source of all energy received on the earth's surface.
The unbroken oneness of the Universe.

### Part II.—Explanatory.

II. The Universe: Mode of its Birth and Growth.

*Statement:*—

The Universe, with its non-living and living contents, is the result of the mutual interaction, according to unvarying laws, of the forces and energies possessed by the atoms of which the universe at its birth was composed.

*Proof:*—

Distribution of matter never the same, it moves in different directions and at different rates, involving
Ceaseless redistribution of matter and energy,
Therefore:—

1. Certain portions of matter come together and form new masses,

*or*

2. Certain portions of matter are driven asunder, the one process (1) being evolution, the other (2) dissolution. The result is a change of the like unto the unlike, or of the less unlike to the more unlike; of advance from simple to complex.

The like does everything.
The unlike does some things.

Application of this to
1. *Inorganic Evolution.*
Nebular theory of stellar evolution.
Do. of solar and planetary evolution.
Do. as explaining earth-history.
Slow secular cooling.
Azoic (without-life) period.

Evidences of dependence of the living on the not-living. Therefore life takes its place in the chemical history of the earth.

2. *Organic Evolution.*
Darwin's theory of the origin of species by
1. Natural selection.
2. Descent with modification.

Abstract of his theory:—
*a*. More organisms are produced than can survive.
*b*. The fittest survive.
*c*. No two are alike; the tendency is to variation. Causes of do.
*d*. Variations are transmitted.
*e*. Variations must be in harmony with surroundings.
*f*. Variations result finally in new species.
*g*. Long time postulated as necessary for changes from primitive organism to man.

Proof of his theory from—
*a*. Embryology.
*b*. Morphology (correspondences of type).
*c*. Geological succession (fossil organisms).
„ (intermediate forms).
*d*. Geographical distribution.
*e*. Classification.
*f*. Man's application of it (variation of plants and domestic animals).

Evolution of mind as special form of life.
Dependence of the psychical on the inorganic.
Mind correlated with a complex nervous system, therefore with a material process.

3. *Super-Organic Evolution.*
Application of the theory of evolution to society, morals, theology, language, art, science.

Throughout the foregoing explanation no unknown agencies invoked.

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Force indestructible; Energy constant.
Eternal changes rung on Evolution and Dissolution.
Ultimate destiny of the visible universe.

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Questions *answered* by Evolution:
Cosmic system explained as natural product of matter, force, and energy.
Origin and development of life and mind, its highest form; therefore explains man as the

most complex and highest result of inorganic and organic evolution.

Questions *unanswered* by Evolution:

What lies beyond the phenomenal.

The beginning of matter.

The origination of motion.

Passage from the action of the brain to facts of consciousness.

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Application to that which most concerns man, namely, human relations.

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## OPTICAL RECREATIONS.

By a Fellow of the Royal Astronomical Society.

### COLOUR AND LIGHT.

IN describing the refraction of a ray of light by means of a prism (Knowledge, Vol. VI., p. 46) we incidentally referred to the fact (only, however, immediately to dismiss it) that the image of any object seen through such a prism was edged with brilliant colours, and that, in fact, white light passing through it was separated into a sheaf of rays of different refrangibilities, or capacity for being bent from a straight path. For the better comprehension of the subject of colour generally, and of the colours of objects in particular, it now becomes necessary to revert to the use of the prism, and to endeavour to ascertain of what so-called white light is composed, and how it comes to pass, for example, that while a geranium is scarlet its leaves are green.

But before proceeding to our preliminary experiment, let us for a few moments devote ourselves to the consideration of a subject concerning which a good deal has appeared from time to time in our late Correspondence Columns. We have insisted, over and over again, in these papers on the fact that light consists of a series of waves or undulations in some substance which fills the visible universe; and which, for want of a better name, is called the æther. This undulatory motion is purely mechanical; but the tiny waves, by ultimately beating upon the retina of the eye (Fig. 1) set that in

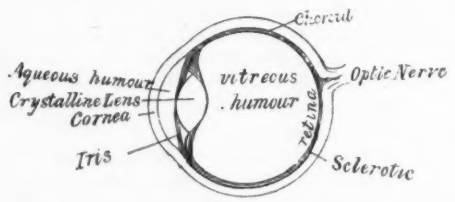



Fig. 1.

turn in vibration, which vibration is communicated by means of the optic nerve to the brain. Then, and not until then, do these purely mechanical undulations become light, as we know it. Furthermore, the multitude of waves of which ordinary white light is composed are of the most various lengths. If we suppose that their length is $\frac{1}{39\,\frac{1}{2}\,80}$th of an inch, we shall see what we call red; shorten them to $\frac{1}{47\,\frac{1}{2}\,60}$th of an inch, and we have the sensation of green; shorten them still farther to $\frac{1}{54\,\frac{1}{2}\,90}$th of an inch, and the eye translates them into violet and so on, the colour varying with the length of the wave. But, and this is the point to be especially noted, until they reach the sensorium, they are mere mechanical vibrations. It is the brain, and that alone, which renders them as *colour*. Perhaps this may not be an inappropriate place to add a word, as to a little difficulty which may at this point possibly have struck some very careful reader. We refer to the fact of these rays of such varying lengths all reaching the eye at once. Well, the explanation of this is of a sufficiently simple character. In reality, the undulations are not only of various lengths, but travel with various velocities; the smaller undulations travelling more quickly than the larger ones, and so all arriving at the eye at once: just as a crowd of men, women, and children might travel in a compact mass if the children took two or three of their little trotting steps to every single stride of the men, and the women timed their pace correspondingly. And now we will proceed to our experiment.

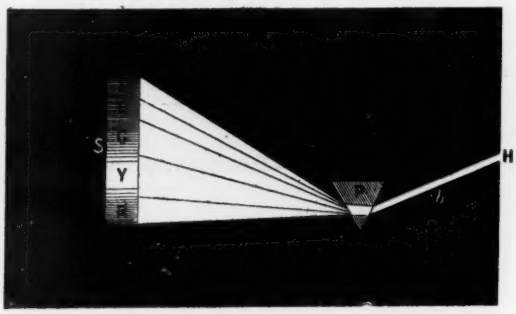



Fig. 2.

Through a hole H (Fig. 2) in the closed shutter of an otherwise thoroughly darkened room, a beam of sunlight H *b* is allowed to enter; and, of course, as every one knows, will, if uninterrupted, form a round spot of light somewhere on the floor. If now, though we turn one side of the prism (seen endways at) P towards the beam of light, it will pass through the prism, and be projected on a white screen suitably placed, as a long streak of the most gorgeous colours; those in fact vulgarly known as "the colours of the rainbow." If we suppose our prism to be placed as in the figure with a sharp edge downwards and its flat base at the top, we shall note that, beginning at the top, the light is of a dull violet; this shades into a strong blue; as does that into a greenish blue, melting in turn into green. Then we arrive at a region of the spectrum (as our strip of coloured light is called), where greenish-yellow and orange-yellow intermingle in a way which renders the observer doubtful whether pure yellow exists at all. As we descend still farther, the orange-yellow becomes a pronounced and decided orange, and this shades into scarlet, which deepens into a crimson when the spectrum terminates. It will hence be seen, as before intimated, that the violet rays are the most bent from their original path, the crimson ones the least so. We have, as a matter of fact, been repeating Sir Isaac Newton's classical experiment, by the aid of which he demonstrated the compound nature of light. We may avail ourselves of another device of his in this investigation, a device shown in Fig. 3.

It enables us to isolate any particular colour, and to examine it apart from the rest, and consists of a narrow slit *s* in the screen S, letting through light of one refrangibility only. If instead of admitting our beam of sunlight through a round hole in our closed shutter, we

let it in through a very narrow slit, and place the refracting edge of our prism parallel to the length of such slit, we shall obtain a very much purer spectrum, in fact one in which the overlapping of the colours is reduced to a minimum; and any particular tint separated as above described from such a spectrum, is quite indecomposable by refraction through a second prism placed behind the aperture *s* in the screen. As might, of course, have been anticipated, if we receive our spread-out spectrum on a concave mirror, so as to recombine the various colours, the resulting image projected on to the ceiling or a screen, will be a spot of white light. There is this notable

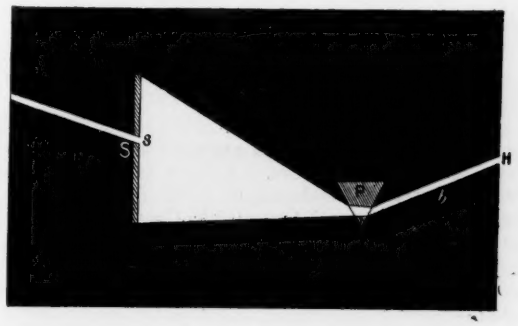



Fig. 3.

difference between the pure colours furnished by the prismatic image, and those emanating from objects lighted by ordinary sunlight: that the latter are always paler than the colours of the spectrum, owing to the admixture of white light with them; the green of a leaf for instance falls short of the green of the spectrum in intensity. It is diluted in this way. And even the strange and almost bizarre colours produced by polarised light fall

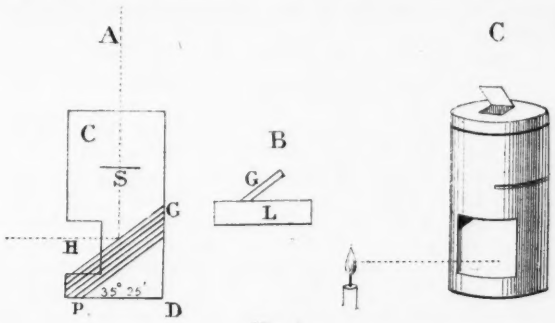



Fig. 4.

slightly short of the purity of those of the prismatic spectrum, as may be seen by splitting off a very thin film of selenite, and inserting it through the slit S in the canister in Fig. 4 (here reproduced from p. 269, Vol. VIII.), so that the beam of light from the bundle of mirrors passes through it *en route* to the smaller one in the lid. A magnifying glass may be used for this observation, if its focus be long enough to enable it to be held at a sufficient distance from the little mirror. Tartaric acid, too, crystallised on a plate of glass and placed in a similar position, exhibits gorgeous colours; yet, as we have just remarked, not quite equal in vividness and purity to those which we obtained by the aid of our prism, an observation equally applicable to the rays of colour in a soap-bubble about to burst.

*(To be continued.)*

## OUR GALAXY.

### LETTER TO SIR J. HERSCHEL.

By Richard A. Proctor.

*London, July* 24, 1869.

I HAVE for several months had it in my thoughts to write to you respecting certain views which seem to me to result from what has been discovered respecting stars and nebulæ, and in particular from the unrivalled series of observations which the scientific world owes to your father and yourself. I have, however, had several reasons for delaying. I have not cared to bring the matter before you until I had gathered a sufficient amount of evidence—and also I have had some diffidence in making a statement which sounds at a first hearing as though intended for a correction of the impressive theories of Sir W. Herschel; though all who have really studied his successive essays on the universe will recognise in my work merely an attempt to advance on the road which he pioneered. If the attempt is a failure you will not the less readily recognise its object.

Although the evidence I have now gathered is far from being so complete as could be wished, yet it is I think sufficient to support many important general conclusions. If it might not seem so to others I think it will to you, who have the means of forming a much readier decision than any man of science now living could do. This is, in fact, one of my reasons for submitting my views to you rather than to any other. There are many eminent mathematicians, many profound physicists, but I know of no one but yourself who is at once mathematician, physicist, and observer, while possessing besides, that knowledge of the whole range of astronomical facts which seems required in deciding on matters such as those I wish to submit to you.

My object is, briefly, to show that there are reasons for modifying our views as to the distribution of stars and nebulæ throughout space. Our own galaxy appears to be rich in a variety of forms of matter or of aggregation not hitherto ascribed to it. It would seem that within a single region of our sidereal system there may be collected,—stars of every variety of magnitude, star-groups of every degree of resolvability, star-streams, gaseous masses, gaseous systems, and in fact all the features which we have been in the habit of looking upon as characteristic (not of any finite portion of our system but) of that quasi-infinite expanse of discernible space whereof our own galaxy has been thought to occupy but a corner.

I will present the points of the evidence as they occur to me, without in general indicating their bearing on my views (to save time and also because you will see in a moment how each part of the evidence bears on the case). Many of the facts are of course already well known to you: but I mention them to make the case complete.

1°. When the irresolvable nebulæ in your large catalogue are isographically distributed (in the manner carried out by you on a smaller number) we find that they show a marked preference for extra-galactic space. Their withdrawal from a given great-circular zone, if not accidental, indicates their association with the sidereal scheme by *some* law. And, as the separate nebulæ have every variety of position, the coincidence of our own galaxy (assumed to be *one* of the nebulæ) with the vacant region—both in place and in position or direction—is too remarkable to be readily accepted as but an accident.

2°. The very easily resolvable nebulæ affect the galactic zone very decidedly, the less easily resolvable nebulæ

affect that zone less markedly, the irregular nebulæ (gaseous) are all on or close to that zone, the planetary (also gaseous) affect its neighbourhood. I need not point out the separate significance of these facts, or their yet greater significance when taken in combination with the fact that irresolvable nebulæ withdraw from the neighbourhood of the galaxy.

3°. Wherever there is a large extra-galactic space singularly clear of lucid stars there also irresolvable nebulæ are singularly few in number.

4°. But where amidst a number of small stars there is a small space singularly clear of stars, there nebulæ are abundant (as both your father and yourself testify).

[These are not contradictory as they seem at first sight. If we suppose irresolvable nebulæ to be simply aggregations of small stars and star material in place of single (relatively) large stars, we can understand that nebulæ and lucid stars should be wanting *together*, or that in small-star neighbourhoods the formation of nebulæ should *drain* the district. Both facts require to be accounted for as not accidental, and no other explanation seems possible, while this one seems at once natural and satisfactory.]

5°. There are in places well-marked star-streams—such as the River Eridanus which the moderns have carried farther towards the South Pole, and the stream from the water-can of Aquarius, which the moderns have carried over the back of Grus towards the south.

6°. The two last-named streams of stars lead up to the two Magellanic Clouds.

7°. There are well-marked nebular streams in both hemispheres; but two singularly distinct streams in the southern.

8°. The two last-named streams of nebulæ lead up to the Magellanic Clouds.

9°. One of these streams agrees with one of the star-streams named above, the other with the other!

10°. In the Magellanic Clouds are mixed up stars and nebulæ.

[The Clouds and the evidence they give have been so clearly treated in your "Outlines of Astronomy," that I have no reason for dwelling on the significance of 10°. In conjunction with 5°-9° the evidence seems to me absolutely conclusive as to the association between stars and nebulæ.]

11°. Every one of the irregular nebulæ is strangely associated with stars, which seem (but only seem) to lie much nearer to us. Your maps (in "Southern Observations") and descriptions appear to me conclusive on this point, even where you seem to avoid enforcing the conclusion or to adopt a contrary one. If the coincidence could be accidental in one case, could it in so many?

12°. The Orion nebula has long faint branches extending to $\varepsilon$ and $\iota$ Orionis and condensing around those stars. Can this be accidental? And if not, does it not prove these important points: first that a nebula may be no farther off than lucid stars, and secondly that lucid stars so far apart as $\varepsilon$ and $\iota$ Orionis may belong to a single system?

13°. All those stars mixed up with the Orion nebula whose proper motions have been ascertained, have proper motions singularly small, and coincident in direction—indicating (in a new way) their belonging to one system.

14°. The other stars in Orion have for the most part the same characteristic proper motions (nor need exceptions at all perplex us, considering that we ought to expect them in such cases).

15°. All the stars in Orion (says Secchi) have similar spectra. (Even if this remark is inexact the general significance of what Secchi has observed cannot be misunderstood.)

[The last points go to prove the real oneness of the Orion stellar and nebular system.]

16°. In particular regions of the heavens particular spectral types prevail—indicating the existence of *star-systems* among the constellations—*i.e.*, among lucid stars. The evidence given by this fact, looked on as subsidiary to the evidence for star-streams, seems important.

17°. In particular regions of the heavens the stars seem to be drifting in a mass towards the same directions.

[I send a rough copy of a portion of a map of proper motions I am preparing for next meeting of the Royal Astronomical Society.]

18°. The proper motions of stars of smaller magnitudes are not small enough (on the average) for the accepted views as to star-distances. I have taken the proper motions in Main's Catalogue of 1,167 stars common to Bessell's Catalogue and Greenwich Catalogue, and using the formula:—

$$\text{Mean proper motion} = \sqrt{\frac{\text{sum of square of}}{\text{proper motions.}}}$$

I get:—

Mean proper motion of stars of 1st 3 mags. $= 0''{\cdot}301$
" " " next 3 mags. $= 0''{\cdot}302$ } !!

[I believe this result to be much more than sufficient to prove 18°; but I do not by any means accept it as it stands—or as otherwise than accidental so far as its significance in regard to detail is concerned. Its general significance is as trustworthy as it is obvious.]

19°. The same result follows from the small effect of the correction due to the sun's proper motion, when estimated with reference to the commonly-assumed stellar distances.

[I venture to point out that it is doubtful whether Mr. Dunkin's result on this point is, as you suggest, that which was to have been *expected*. Does not your reasoning, founded on the number of stars which are moving hither and thither with their *real* proper motions, apply both ways. Every one of those stars is affected by the sun's proper motion. I find by the ordinary rules for determining means that the correction due to the sun's motion ought to be exactly one-half of the sum of the squares of the proper motions, if the sun's motion is equal to the average of stellar motions. There is a simple geometrical proof of this, the chief points of which are as follows:

—Let S A = displacement due to sun's motion, S $S_1$ = S $S_2$ = motion of two stars in opposite directions from S, *foreshortened* and really equal to S A. Then,

Sum of squares of opposite motions = $S_1 A^2 + S_2 A^2$,
Sum of squares of ditto *uncorrected* = $S S_1^2 + S S_2^2$,
and former sum exceeds latter by 2 S $A^2$ (one S $A^2$ for each).

And the effect of foreshortening on all motions from S, precisely corresponds to the effect of change of position of S in diminishing S A. Hence for the whole sphere there is an exact equality between

the effect due to the stars' own motions and the effect due to the sun's motions, assuming,—

1. Sun's proper motion = stars' average proper motion.
2. Motions equally distributed in all directions.
3. Stars equally distributed through space.

The evidence (obtained by Mr. Dunkin) that the sun's motion does *not* correct the stars' motions in this proportion—*i.e.*, by one half, establishes the probability that the distances of stars of smaller mags. have been underrated—and that therefore the extent of the effect of the sun's motions upon such stars has also been underrated.

20°. The stars of smaller mags. are not so numerous as they should be according to the theory of uniform distribution.

[Professor Nichol speaks of their number as "according with their theoretic distances," but Struve's hypothesis of the extinction of light was devised to account for a marked want of accordance in this respect.]

21°. The general appearance of the Milky Way is not that which either the theory of a cloven disc, or that of a flattened ring, requires.

[Sir W. Herschel was gradually modifying the disc theory—necessarily the *first* to be adopted after his gauging processes; and you have spoken in many places of the evidence which appears in form of a modified view.]

22°. The well-defined edges of parts of Milky Way prove we are outside its streams; for no cluster of objects within which (cluster) the observer is situated can anywhere appear with well-defined edges.

23°. The great gap in Argo is not explicable on either the disc or the flat-ring theory.

24°. The "Coalsack," though more readily explicable on the latter than on the former, remains a difficulty with either.

25°. The singular want of lucid stars in the "Coalsack" and between the branches in Scorpio, &c., is another difficulty.

26°. The break in the second stream of the Milky Way is a great difficulty.

27°. The knots and clustering aggregations along the Milky Way seem to require a different theory.

[The view I would suggest as roughly explaining observed phenomena is the following* :—This explanation accounts for the singular diminution of brightness from Cygnus to Ophiuchus, and the equally singular increase from Cygnus to Aquila.

Fig. 1. A perspective view of Milky Way supposed to be depicted on a crystal globe.

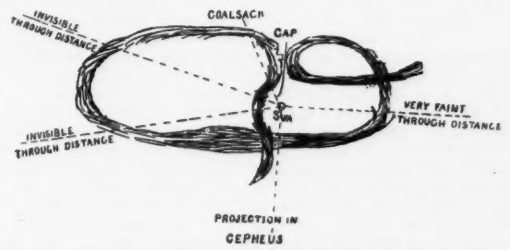



Fig. 2. Suggested general figure of Milky Way spiral in space.

* The figures are copied directly from the sketches in the rough draft of my letter.

28°. The lucid stars near the Milky Way seem to be intimately associated with it—especially in certain regions.

29°. Along that part of the Milky Way which I have put on the nearest part of the spiral the stars have in many instances singularly large proper motions—also 61 Cygni, and $\alpha$ Centauri, the nearest known stars are on this branch.

30°. The proper motion of the Sun is such as the dynamical conditions suggested by my spiral seem to require.

31°. There are in many parts of the Milky Way outlying streamers. On either the flat disc or the flat ring theory we cannot readily conceive these to be "columnar excrescences bristling up from the general level." Yet were it not for the strong antecedent improbability thus indicated, this would be the natural conclusion, because it is clearly unlikely that *several* sheets of stars would be seen edgewise, even though *one* might be.

32°. In places, a projection of the Milky Way has its apex coincident with a bright star.

Many other points might be dwelt upon—as

33°. The fact that certain forms of aggregation are singularly common in certain regions (double stars are less common in Southern heavens, you have noted).

34°.—Variable stars are more common in some places than others—and sometimes variables in certain districts are characterised by the same law and mode of variation, &c.

35°.—The "access to the Nubeculæ* on all sides is through a desert" (Why? unless those regions have been *drained* to form the Nubeculæ).

36°.—The fact that many regular nebulæ are singularly associated with single, double, or multiple stars.

37°.—The existence of those faint "mottlings" (forming streams) which you detected in the southern heavens.

38°.—The fact that in such clusters as Præsepe and Perseus we find nebular tracts (in the former two distinct nebulæ), and that the probability is enormously against this being accidental.

39°. The breaking out of new stars on the borders of the Milky Way.

40°. The indicated existence of dark orbs (causing the irregular proper motions of Sirius and Procyon).

41°. The occurrence of such a change in a star as would lead to the appearance of a so-called "new star"—since it seems far more reasonable to believe that a really minute star has thus suffered a fire change than that a sun resembling ours has suddenly blazed out to many times its usual brilliancy.

42°. The variability and disappearance of many nebulæ.

But for the present the facts before cited seem sufficient for my purpose.

*Per contra* I know of very few definite facts. There is the general feeling of experienced observers that the nebulæ are far beyond our sidereal system. But on such a point experience avails nothing—or rather no one has yet obtained any experience enabling him to form an opinion, *from observation*, on this point. Experience can tell an observer whether a star apparently single is likely to be doubled with a moderate increase of power; whether an unresolved nebula is or not resolvable and so on: because on these points an observer *can have* experience. But the opinion an observer may form as to the distance

* Another name for the Magellanic Clouds.

XUM

of a nebula can never be confirmed or disproved, and so he can never acquire real *experience* on this subject.

Many view the careful study and analysis of observations, work which they call "paper astronomy," with contempt. You are not likely to share that feeling, remembering that Copernicus, Kepler, and Newton—to name no more—were paper astronomers. I feel that there is room for a good deal of paper astronomy on the subject of this letter; and that it would be good service to enlist fellow-labourers in *paper-work*. It is not that I undervalue observation—rather that others do. A large mass of observations is available to modern thinkers—but most men prefer to make new observations. In this way the real worth of observation is lost; and further, many who take part in it would do better work in other directions.

My object in writing is very much as follows:—I have been trying to show that useful results could be obtained if a few who have time would overhaul the accumulated mass of observations now lying at the disposal of astronomers. I have myself very little time to work at this subject. If I can save an hour or two a week for such work, it is as much as I can do without injustice to my family. I should like to see many of those now engaged in accumulating preposterously useless observations at work in the field over the fence of which I have looked. A hundred modes of inquiry should be followed up; observed facts should be co-ordinated and rendered significant; new modes of observation should be devised. Thus may clear views, perhaps, be obtained respecting that which it has hitherto seemed hopeless to inquire about—the arrangement and configuration of the star-groups in our own neighbourood, the architecture of the nearer portions of the sidereal heavens.—Yours very truly,

R. A. Proctor.

## THE UNIVERSE.

### LETTER TO RICHARD A. PROCTOR.

By Sir John Herschel.

*Collingwood, Aug.* 1, 1869.

I HOPE you will not regard my delay in replying to your letter of the 24th [ult.] as indicating any absence of interest on my part in its subject matter, or in the views you have been led to base on the constitution of our sidereal system. On the contrary, it has been precisely by reason of the number and variety of the striking facts you have brought together, and the evident bearing of a great proportion of them on the great problem it offers to human speculation, that I have been unwilling to make a hasty reply.

I have never participated in that feeling which you designate as "a contempt for astronomy on paper" in the sense of repudiating such speculations as aim at grouping together known but apparently disconnected facts, within one general view, in consonance with known laws,—holding that in the midst of so much darkness we ought to open our eyes as wide as possible to any glimpse of light, and utilise whatever twilight may be accorded us, to make out, though but indistinctly, the forms that surround us.

Under this impression, I should not feel so bigotted to the "ring" or the "disc theory" of the Milky Way, as to reject your proposed system of convolutions, which certainly seems to give a plausible, if not a fully satisfactory account of the gap in Argo, and the break in the following branch of the double stream about Ophiuchus; though I confess that the "Coal-Sack" does not at all give me the idea of the perspective view of a loop, formed by the visual ray passing over one portion, and under another,* of one and the same continuous belt: and the disappearance by the simple effect of remoteness of the interrupted stream in Ophiuchus, would involve, in consequence, a regular progressive diminution in magnitude of the component stars, in approaching the break from either side, down to unresolvable nebulosity and thence to evanescence.†

I do not see the absolute necessity for placing the sun fairly out of the Belt. Distant portions of the Belt from which the sun's position is quite remote may still appear sharply terminated,—and it is a fact that abundance of stars of all magnitudes *are seen* in situations inclined at all angles to the galactic plane, their density increasing gradually and regularly down to that plane.‡

The considerations you adduce relative to the proper motions of the stars are exceedingly curious and interesting.§ Of late years catalogues have gone into so much detail, and with such accuracy, that these motions are, of course, much better known to us than some twenty or thirty years ago. The community of proper motions over large areas, of which you give a picture in Gemini and Cancer is most remarkable, and the coincidence of proper motion in $\beta$, $\gamma$, $\delta$, $\epsilon$, and $\zeta$ Ursæ Majoris is most striking. Your promised paper on this subject cannot fail to be highly interesting.

I cannot say that I am at all surprised at its being found that the average proper motions of stars of small magnitude is not less than of large, considering (as I have always done) that the range of individual magnitude (*i.e.*, lustre) must be so numerous that multitudes of *very* minute stars may in fact be our very near neighbours. But your remark (in your No. 19) on the conclusion I have been led to draw relative to the small effect of the correction due to the sun's proper motion, will require to be very carefully considered, and I shall, of course, give it every attention.

In my Isographic Projection of the Nebulæ, I made no distinction or separation into classes, &c. You appear to have done so (in your second proposition); and the connection of the great mass of globular clusters with the Milky Way in the region about Sagittarius and Scorpio, has led me to conclude, as you seem to have done, a decided connection with, and, in fact, inclusion, in that system, of the clusters in question.

A remark which this connection, and the structure of the Magellaine Clouds, has often suggested to me, has been strongly recalled by what you say of the inclusion

* I am quite with Sir John Herschel on this point, since I have seen the Southern Heavens.—R. A. P.

† By no means necessarily. It is easy to conceive a star-cloud or stream in which the arrangement of the stars of various orders would be such that no order would ever present unresolvable nebulosity at any distance, while the several orders would present the same appearance at all distances, the brighter orders taking the place of the fainter (apparently) as the distance increased.—R. A. P.

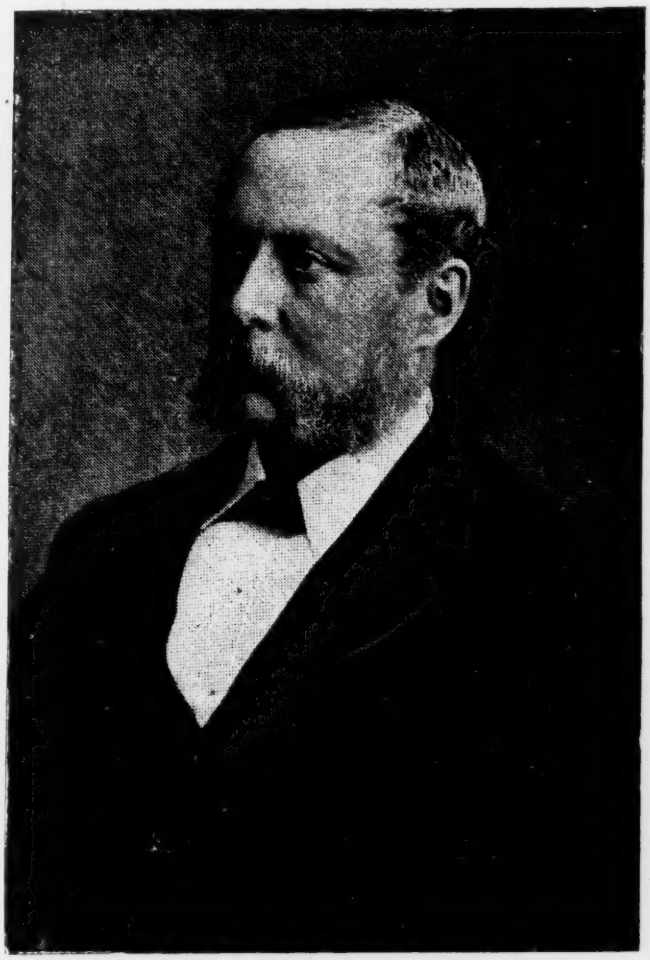
‡ On trying Sir John Herschel's gauges in the Southern heavens on a plan proposed by me, and accepted as trustworthy by Sir J. Herschel, Mr. Sydney Walters found the increase of density to be—as I had anticipated—by no means gradual and regular, but rapid, and as it were sudden, in the neighbourhood of the Milky Way, and irregular over the visible cloud-like gatherings in the galaxy.—R. A. P.

§ Sir George Airy, in a letter addressed to me in February, 1873, confounded my discovery of Star Drift with what Pond, his predecessor as Astronomer-Royal, had already noticed. But Pond's observation applied solely to the general drift of all the stars in the heavens, on account of the sun's proper motion through space. This is a very different matter from the drift of star groups, which I had indicated in my maps of stellar proper motions.—R. A. P.

of every variety of nebulous or clustering form within the galaxy:—viz., that if such be the case (*i.e.*, if these forms belong to and form part and parcel of the galactic system), then that system includes *within itself miniatures of itself* on an almost infinitely reduced scale: and what evidence, then, have we that there exists a universe beyond—unless a sort of argument from analogy that the galaxy with all its contents may be *but one* of these miniatures of that* more vast universe; and so on *ad infinitum*: and that there may be in *that* [more vast universe] multitudes of other systems on a scale as vast as *our* galaxy; the analogues of those other nebulous and clustering forms which are not miniatures of our galaxy.†

I hope you will not be deterred from dwelling more consecutively and closely on these speculative views by any idea of their hopelessness which the objectors against paper astronomy may entertain—or by the real slenderness of the material threads out of which any connected theory of the universe (at present) has to be woven. *Hypotheses fingo* in this style of our knowledge is quite as good a motto as Newton's *Non fingo*—provided always they be not hypotheses as to modes of physical *action* for which experience gives no warrant.—I remain, dear sir, yours very truly,

J. H. W. HERSCHEL.



RICHARD A. PROCTOR, Editor of KNOWLEDGE.

(Printed from a Luxotype process-block.)

## LUXOTYPE AND THE EDITOR'S PORTRAIT.

THE portrait of the Editor has been obtained by the Luxotype method, about which we wrote at some length in June, 1884. In this method the engraving is purely a nature-process,—landscapes, paintings, and animals (including the human animal divine) can be taken in this way without aid from the engraver, except perhaps to remove here and there such flaws or defects as must occasionally appear even in nature's work. Art comes in, of course, as in ordinary photographic work,—and to this, no doubt, must be attributed the strange mistake of a critic who praised certain luxotype landscapes in a monthly magazine because of the artistic skill with which the engraver had—so said the critic—transformed and spiritualised nature's features! We hope soon to have other opportunities of showing the great value of this new process, and of associated improvements invented by Messrs. Brown, Barnes, & Bell.

We have to thank Messrs. Elliott, Fry, & Co. for permission to reproduce this portrait from their gallery, and for their special kindness in lending the original negative.

* Possibly a mistake for "a," "that" being anticipated from the, emphatic "that" presently required, and as it were *felt coming*. But the reference may, of course, be to the previously mentioned "universe beyond."—R. A. P.

† Here, as elsewhere in this letter, Sir John Herschel writes in a condensed form, very suitable for the occasion (addressing as he was one who was already fully engaged upon and with the subject) but not quite so fully, or therefore so clearly, as he would have deemed necessary, had he been writing to one viewing the subject from outside. The idea of the universe here presented, one of the grandest that could be imagined, may be illustrated thus:—Imagine insects, examining twigs from some distance, at first under the mistaken idea that they were really boughs, much farther away than they seemed to be. If now any evidence suggested that these objects were not so far away, and being near were *really* smaller than the boughs, a thoughtful insect might say, They seem to belong to the bough, and some of them to be miniatures of it; if so, he might continue, What evidence have we of a bough beyond, unless a sort of argument from analogy that this bough with all its twigs may be but such a miniature of a more vast kind of bough—[a *tree* as our wider knowledge tells us], and that there may be in that [tree] multitudes of other boughs, on a scale as vast as ours, those other boughs corresponding on a larger scale to the other twigs on our bough which are not miniatures of it?—R. A. P.

THE BRITISH RACE OF TO-DAY.—The British race of to-day ought to be tough and enduring, for it has been welded in the past by many beatings. It is a race stubborn to endure, but it is also a race ready to attack. If we are descended from races which have been well beaten, we are descended also from races which have well achieved victory. We share the blood of the Britons, whom the Saxons overcame, but we share also the blood of the Saxons who overcame the Britons. We descend from the Saxons whom the Normans subdued, but we inherit also the blood of their Norman conquerors. It is probably this mixture of many qualities good in contest, fierceness in attack, resolution in defence, daring in enterprise, stubbornness in endurance, which has made the British race what it is. It wants some of the finer qualities we admire in the nations of antiquity, though not altogether unlike the Roman race in some respects. But at present it is beyond all question predominant in the world.

b

## INDIAN MYTHS.

By "Stella Occidens."

Should you ask me, whence these stories—
Whence these legends and traditions?
* * * * * *
I should answer, I should tell you,
From the forests and the prairies,
From the great lakes of the Northland,
From the land of the Ojibways,
From the land of the Dacotahs.
* * * * * *
I repeat them as I heard them.—Longfellow.

DURING the long, cold, winter nights, the Indians gather round the camp-fire, and relate the wonderful tales and myths of their country. Under the great pines, in an ever-green forest of the Rocky Mountain region, by the blazing light of the camp-fire, and surrounded by the darkness of night, stands an old man, telling in simple language the story of Ta-wăts, the hare-god, and his encounter with Tä-vi, the sun-god. The Indians are great actors, and tell more by action than by words. The elders listen with reverence, whilst the younger members are often so excited as to dance with delight, or shiver with fear, according to the influence of the orator and his story.

The old man tells them how in long past times the sun god Tä-vi was free to roam about the world at pleasure, scorching people when he came too near, and leaving them shivering with cold when he hid away in his cave. One day Ta-wăts, the hare-god, was sitting round the camp-fire, out in the woods, with his family gathered round him, waiting for the sun-god to come out of his cave and warm them. At last they grew tired of waiting, and fell asleep. The sun-god then approached the hare-god and his family so near that he scorched Ta-wăts' shoulder. Then Tä-vi ran away and hid himself, for he was afraid that the hare-god would be angry. When the latter woke up, and found how badly the sun-god had treated him, he was very angry, and determined to be revenged. He travelled for days and days, meeting with many adventures, and overcoming many obstacles. At last he arrived at the brink of the world, and here he waited patiently until he should see the sun-god. Presently the latter, thinking his enemy had gone, peeped out, and the hare-god shot an arrow in his face, but the rays of the sun burnt the arrow before it reached him. Ta-wăts shot again and again without effect, until at last he sent a magical arrow, which never failed to reach its mark. This struck Tä-vi full in the face, and the sun fell to pieces, setting the whole earth on fire. The hare-god fled, but as he fled the burning earth scorched his feet, his legs, his body, until at last only his head was left. This went rolling along, bumping over rock and crevice, across mountains and valleys, through deep ravines and abysses. Finally the eyes of the hare-god burst, and tears gushed forth in such a flood that it quenched the fire. The sun-god was conquered, and he was summoned to appear before a council to await sentence. The judges condemned him to travel across the sky day after day, on the same path, and he was only to appear at certain times. The days, nights, months and seasons were also regulated by this council.

The Algonquin race have the beautiful myth of the Red Swan, somewhat similar to the above. They believe that the hunter Ojibwa, whilst skinning a bear, noticed that the sky gradually became tinged with a bright red light. He saw a beautiful red swan with brilliant plumage flying across a lake, and tried in vain to shoot it, his arrows proving useless. He then tried three magic arrows, only succeeding, however, in striking the swan with the third. The wounded bird flew off, feebly flapping its wings, until it sank at last under the water. Ojibwa pursued the red swan westward, and discovered that she was the daughter of an old magician. The old man had lost his scalp, which Ojibwa found for him, and put back on his head. The magician then gave his beautiful daughter, the Red Swan, to Ojibwa, as a bride, and they returned to the earth together. In Longfellow's "Hiawatha," this myth is referred to by Iagoo, the marvellous story-teller, at Hiawatha's wedding, when he relates the story of "The Son of the Evening Star":—

Can it be the sun descending
O'er the level plain of water?
Or the Red Swan floating, flying,
Wounded by the magic arrow?
Staining all the waves with crimson,
With the crimson of its life-blood,
Filling all the air with splendour,
With the splendour of its plumage?

Shortly after the Sun had been condemned to travel across the sky, another council was held to elect a Moon which was to shine during the night. Whippoorwill, God of the Night, was chosen to preside at this council. After a long debate, a frog offered himself as a willing sacrifice, and was chosen. Various magical incantations and ceremonies were used, and he was changed into the new Moon. Naturally the Moon gives no heat, being made out of the cold body of a frog.

The Dahkotah Indians believe that the Moon is made of something good to eat—as good, probably, as green cheese. When the Moon is full, a great number of small mice commence nibbling until they have eaten it all up. A new Moon then begins to grow until it is full, when it is in turn devoured.*

The Dahkotahs count their months by the Moon, as follows:—

1. Witeri, *January;* the hard Moon.
2. Wicata-wi, *February;* the racoon Moon.
3. Istawicayazan-wi, *March;* the sore-eye Moon.
4. Magaokadi-wi, *April;* the Moon in which the geese lay eggs; also called Wokada-wi; and sometimes Watopapi-wi, the Moon when the streams are again navigable.
5. Wojupi-wi, *May;* the planting Moon.
6. Wajustecasa-wi, *June;* the Moon when strawberries are red.
7. Canpasapa-wi, *July;* the Moon when choke-cherries are ripe.
8. Wasuton-wi, *August;* the harvest Moon.
9. Psinhnaketu-wi, *September;* the Moon when rice is laid up to dry.
10. Wi-wajupi, *October;* the drying rice Moon.
11. Takiyura-wi, *November;* the deer-rutting Moon.
12. Tahecapsun-wi, *December;* the Moon when the deer shed their horns.

The Indians have many myths concerning Day and Night. Schoolcraft, in his "Algic Researches," describes the Huron nature-myth concerning Day and Night:—"Iosco," says Tylor, "seems to be Ioskeha, the White One, whose contest with his brother Tawiscara, the Dark One, is an early and most genuine Huron nature-myth of Day and Night. Iosco and his friend travel for years eastward and eastward to reach the sun, and come at last to the dwelling of Manabozho, near the edge of the world; and then, a little beyond, to the chasm to be passed on the way to the land of the Sun and the Moon. They begin to hear the sound of the beating sky, and it seems near at hand; but they have far to travel before they reach the place. When the sky came down its pressure would

* Neill's "History of Minnesota."

force gusts of wind from the opening, so strong that the travellers could hardly keep their feet, and the sun passed but a short distance above their heads. The sky would come down with violence, but it would rise slowly and gradually. Iosco and one of his friends stood near the edge, and with a great effort leapt through, and gained a foothold on the other side; but the other two were fearful and undecided, and when their companions called to them through the darkness, 'Leap! leap! the sky is on its way down,' they looked up, and saw it descending; but, paralysed by fear, they sprang so feebly that they only reached the other side with their hands, and the sky at the same moment striking violently on the earth with a terrible sound, forced them into the dreadful, dark abyss."*

The Ottawa tribes also believe the Sun and Moon to be brother and sister. "Two Indians, it is said, sprang through a chasm in the sky, and found themselves in a pleasant moonlit land. There they saw the moon approaching as from behind a hill; they knew her at the first sight; she was an aged woman with white face and pleasing air. Speaking kindly to them, she led them to her brother, the Sun, and he carried them with him in his course, and sent them home with promise of happy life."†

There is an Ottawa myth about Manabozho, the solar god, among the Algonquins, which tells about his driving his father, the West, across mountain and lake to the brink of the world, but he was not able to kill him. This conflict is described in "Hiawatha"; the West-Wind or Mudjekee'wis being the father of Hiawatha.

> Then began the deadly conflict,
> Hand to hand among the mountains.
> * * * * *
> Back retreated Mudjekeewis,
> Rushing westward o'er the mountains,
> Stumbling westward down the mountains,
> Three whole days retreated fighting,
> Still pursued by Hiawatha,
> To the portals of the West Wind,
> To the portals of the Sunset,
> To the earth's remotest borders
> Where into the empty spaces
> Sinks the sun, as a flamingo
> Drops into her nest at nightfall
> In the melancholy marshes.
> "Hold!" at length cried Mudjekeewis,
> "Hold, my son, my Hiawatha!
> 'Tis impossible to kill me,
> For you cannot kill the immortal.
> I have put you to this trial
> But to know and prove your courage."

In the Ottawa myth, Manabozho is called Na-na-bou-jou, and is the elder brother of Ning-gah-be-ar-nong Manito, the Spirit of the West, god of the country of the dead, in the region of the setting sun. This sun-hero, Manabozho, when he angled for the King of Fishes, was swallowed, canoe and all; then he smote the monster's heart with his war-club till he would fain have cast him up into the lake again, but the hero set his canoe fast across the fish's throat inside, and finished slaying him; when the dead monster drifted ashore, the gulls pecked an opening for Manabozho to come out."‡ This story is likewise told in "Hiawatha," in the account of the Little Monedo of the Ojibwas.

The Oraibi philosopher who lives in a *pueblo* knows something about architecture; therefore he imagines the world to be a building, and seven stories high. We are supposed to occupy the second story, one being below and five being above. The third story is occupied by the rain-god, who sprinkles the earth with rain by dipping a brush made of birds' feathers into the lakes of the skies. The Indians who live on the cliffs of Arizona believe that the rain is sent for the irrigation of their crops and to refresh the thirsty earth. In the winter this god causes a snow-fall by crushing the ice of the heavenly lakes, and scattering it over the earth.

The reason why we occupy the second story of this wonderful building is presented in the following way by the Oraibi philosopher. It was supposed that people originally inhabited a lower world—in fact, the first story. However, they ascended to our world by means of a magical tree, which served as a ladder from the lower world to this. They found the firmament resting low down on the earth, forming the floor of the world, and Mateito, one of their gods, raised the firmament on his shoulders to its present place. He is also supposed to have made the moon out of seven baskets of cotton bolls, woven by seven maidens, and the bits of cotton which were scattered about whilst they worked were made into stars. Mateito then made a sun to keep the people warm, for they complained because the moon was cold. He made the sun of the hair of seven buffalo robes. He also appointed the times and seasons for the heavenly bodies to appear; and the gods of the heavens have obeyed his commands from the day of creation till the present time.

According to the Shoshoni Indians, the sky is ice (being of the colour of ice), and the fall of snow is caused by a monster serpent-god, who coils his huge back against the sky and brushes the ice dust off with his scales. This serpent-god is supposed to be the rainbow,* and the Shoshoni philosophers believe it to be the serpent-god of storm. In the winter-time the serpent sends snow, and in the summer time rain.

Schoolcraft, who spent some time visiting among the Indian tribes, relates a story told by a North American Indian prophetess, describing a vision she had of the Bright Blue Sky. "At her solitary fast at womanhood she fell into an ecstasy, and at the call of the spirits she went up to heaven by the path that leads to the opening in the sky; there she heard a voice, and standing still, saw the figure of a man near the path. His head was surrounded by a brilliant halo, and his breast was covered with squares. 'Look at me,' he said, 'my name is Oshaunauegeeghick, the Bright Blue Sky.'" She likewise described the spirit as being ornamented with the hieroglyphic horns of power.†

The North American Indians called the Pleiades the *Dancers*, and the morning star the Day-bringer. Stories are told of an Indian who had long gazed on a star in childhood. One day it left its place in the heavens, and came down to the earth, and talked with him. When he went out hunting, and had poor luck, the star would lead him to a place where there was plenty of game.‡

The Indian myths about the planet Venus are interesting. Longfellow tells in "Hiawatha" how,—

> "The Star of Evening
> Melts and trembles through the purple,
> Hangs suspended in the twilight.
> No; it is a bead of Wampum

* Tylor's "Primitive Culture." † *Ibid.*, p. 337. ‡ *Ibid.*

* Compare the account of the rainbow by Nokomis, the mother of Weenonah:—

> "'Tis the heaven of flowers you see there
> All the wild flowers of the forest,
> All the lilies of the prairie,
> When on earth they fade and perish,
> Blossom in that heaven above us."

Prettier this than the serpent theory.

† Schoolcraft's "Indian tribes."

‡ Tylor's "Primitive Culture," Vol. I.

XUM

On the robes of the Great Spirit,
As he passes through the twilight,
Walks in silence through the heavens!"

Then Iagoo, the story-teller, relates how Osseo, the son of the wandering star of Evening, was beloved by Oweenee, the "silent, dreamy maiden," who refused "all her young and handsome suitors," and married—

"Old Osseo, poor and ugly,
Broken with age and weak with coughing,
Always coughing like a squirrel.
Ah, but beautiful within him
Was the spirit of Osseo,
From the Evening Star descended."

All the heavenly bodies, indeed, were supposed to be human beings or spirits by the North American Indians. The ghost theory was very obviously held among them, not the mere Fetish worship imagined by some modern writers.

## ELECTRICITY AT HOME.

By W. Slingo.

### ELECTRIC MACHINES.

A PECULIAR charm attaches to electricity, I think, as a source of interest and entertainment, and this apart altogether from the gratification it affords to many thousands as the basis of their daily calling. That this has long been the case is evidenced by what we read of the many devotees to the study of the science during the past two or three centuries. There is, however, some danger, in these days of dynamos and telephones, that what Tyndall has aptly called the "older electricity" will be to some extent lost sight of, or at least regarded with less respect than is merited. This is due, in a measure, to the fact that the study of electricity is bald in the extreme if unaccompanied by experiments, while the cost of performing such experiments efficiently is, as a rule, a heavy item. I should be one of the last to say that the makers of *good* scientific apparatus ask too much for their wares, for the workmanship put into the instruments is worthy of good remuneration; but when one cannot run to the expense of the more costly apparatus, it is false economy to purchase inferior goods. The expense of a first-class article is generally made heavy by the introduction of little details and elaborations, requiring a deal of labour and attention, and yet not essential to the more general application of the instrument, whatever it may be. The working man, moreover, has a tendency to work according to his "stuff," *i.e.*, if he is using common deal where ordinarily mahogany or walnut is employed, he puts in proportionately poorer work and the instrument consequently acts but indifferently. Cheap apparatus is therefore as often as not a delusion. Nevertheless, I think it within the power of anyone of average ability to provide himself with apparatus of a highly efficient character at a comparatively trifling cost. Such apparatus, too, will afford far more pleasure than if it were purchased, while the most inexperienced can, by beginning with simple instruments and producing subsequently more and more intricate ones, gain that experience and knowledge of apparatus which is essential to the real enjoyment of Science and its teachings.

The instrument which, for simplicity of construction, and, at the same time, general utility as a source of experiment, excels all others is the electric machine. With a well-made machine, even if of the smallest dimensions, experiments of an almost endless variety can be performed, while the brilliancy of many of them imparts an interest which for a long time has carried all before it.

Fig. 1 illustrates a somewhat elaborate form of that type of electric machine known as the "cylinder," in which a glass cylinder is caused to revolve between a piece of silk on the one side and a metallically-connected row of pin-points on the other side, the points being connected to a metallic cylinder by means of metal rods, tubes, &c. From such a machine copious discharges of electricity may be readily obtained. Let us, however, consider a simpler form of the instrument, and one which can be well made at a cost not exceeding five shillings. The first thing to do is to get a cylinder. This may consist of a glass bottle or jar such as confectioners use, or it may even be an ordinary plum-jar. It is essential, however, that the surface should be smooth, and free from any irregularities; the sides, too, should be parallel —that is to say, a vertical section should yield two parallel straight lines. Some little care also should be taken in selecting the best or most suitable quality of glass. Some kinds of glass are much inferior to others as insulators. The best sort for our purpose is that

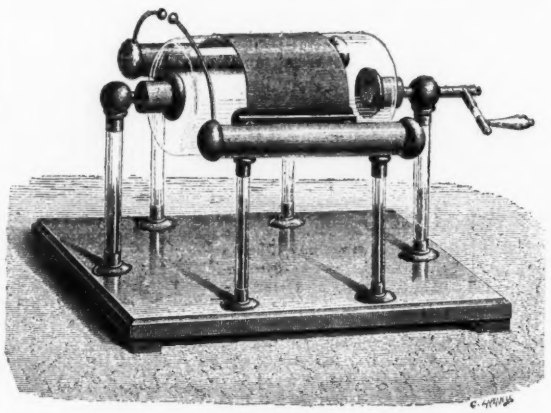


Fig. 1.

greenish-looking glass employed for windows or common bottles. Some trouble is likely to be experienced in procuring a bottle answering to these requirements, and after all it will be found in many cases preferable to purchase a regular cylinder, more especially as the cost is reasonably small, and there is no fear that it will prove too poor an insulator for the purpose. A cylinder four inches in diameter and seven inches long may be purchased for two shillings or half-a-crown. The shape will be found similar to that illustrated in Fig. 2, A B being apertures through which the axis is to pass. Presuming these apertures to be three quarters of an inch in diameter, the axis or spindle may consist of a rod of beech or some other hard wood of about the same diameter. Failing anything better, however, a piece of a stout walking-stick will answer the purpose, or even a broom-handle will do, if one can be procured small enough in diameter. Before the cylinder is fixed on to the spindle the base and supports should be put together so that the cylinder may be properly balanced and a handle fitted. The handle may give a little trouble to make, but it is not a very serious matter. It may be of wood or metal, according to convenience. If it is to be of wood, cut a strip half an inch thick, an inch or so wide, and five inches

long. Near one end cut a half-inch square hole, one end of the spindle being reduced to fit it, a pin being passed through the spindle to prevent the handle working off. The other end of the strip of wood should also be furnished with a half-inch hole to carry the handle proper, which should be well fitted, the portion passing through the strip being at least an inch long, so that a pin or nail may be inserted to prevent the handle falling out. The disadvantage of this arrangement is that the handle itself does not rotate as it revolves, or, in other words, the hand has to slip over it in driving. A much better plan, therefore, is to make a metal handle. This may be done by procuring first a piece of quarter-inch sheet-iron five inches long, an inch wide at one end, tapering down to about five-eighths at the other end. In the wide end drill a hole, and then file out a square hole to fit a corresponding square end produced on the spindle. Next take a piece of quarter-inch iron rod, about five and a half inches long. Produce shoulders by filing a little of the metal away from each end for a distance of five-eighths or three-quarters of an inch at one end (A), and an eighth to three-sixteenths of an inch at

Fig. 2.

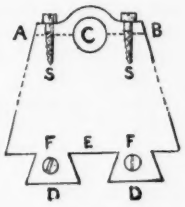


Fig. 3

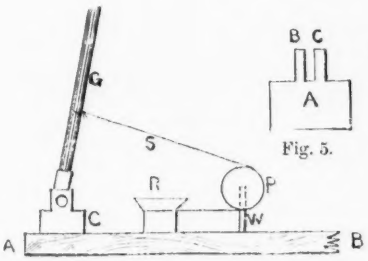


Fig. 4.



Fig. 5.

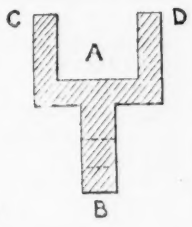


Fig. 6.

the other end (B). Put a metal washer over the end A, the hole in it being only large enough to allow it to pass over the reduced portion of the iron rod. Then drill and file a hole in the narrow end of the strip of sheet-iron, to fit on to the end B of the iron rod. Next place a washer to the protruding portion of B (so that there is a washer on each side of the hole in the strip), then with a hammer well rivet the rod and external washer together, so as to grip the strip tightly. A wooden handle with a hole bored through it from end to end (such as a small skipping-rope handle) is next provided, the hole being a trifle larger than the iron rod over which it is to be passed, and a washer similar to those previously referred to rivetted on to the end of the rod. The wooden handle may then be grasped in the hand when working the machine, as it will pass easily over its iron axis, and so save any risk of injuring the hand, or unduly straining the apparatus.

Let us next turn to the base. The cylinder measures seven inches in length; the projections A B are each about an inch long; half-an-inch clearance must be left between A and B and the respective supports. Allowing, also, three-quarters of an inch for each upright, the total length of the base must be eleven and a-half inches. The breadth should, for reasons presently apparent, be about the same. The thickness of the material should be not less than three-quarters of an inch. The supports should be secured to the base as rigidly as possible. The best plan is to dovetail them. They should be cut from sound stuff three-quarters of an inch thick, and should be three inches wide at the bottom, tapering upwards to two inches or thereabouts—the total length being eight inches or more, and the shape similar to that shown in Fig. 3. With a tenon-saw and keen chisel, the lower portion should be shaped as at D D. Holes should be bored with a centre-bit at C, six inches from E, the diameter being about an eighth of an inch greater than the diameter of the spindle carrying the cylinder. In one of the holes a piece of brass tubing should be inserted, the internal diameter being such as to allow the spindle to revolve easily, but not loosely. The hole in the wood, it is apparent, must be of such a diameter as to cause the tube to fit as nearly as possible to prevent it slipping out. Should there be a tendency to so slip, the tube can be kept in position by indenting each end into the wood, after it has been placed in position. The other upright, after having been bored, should be sawn across, the saw-cut passing through the centre of the hole, as shown by the dotted line, A B. A piece of brass tubing, similar to the one already used, should then be sawn in two, longitudinally, and one of the parts placed in each half of the hole divided by the saw. A single small screw will be sufficient to keep the half-cylinders of brass in position, care being taken, however, to well countersink the screw-hole, and to file off any burr or asperity of any kind that may be left, which, if not removed, would ultimately tend to destroy the spindle. The brasses having been fitted, the upper portion of the support is ready for receiving the spindle and then being screwed down, as at S S, to the main portion. The ends of the base should next be cut, so that the upright supports may fit as closely as possible. If there is the slightest tendency to looseness, means should be taken to overcome or prevent it. The readiest plan is to screw the uprights to the base at F F. The cylinder may now be threaded on the spindle, placed in position, and balanced. It is likely that the spindle will not fit both the apertures tightly. If so, the intervening space may be fitted with thin wedges of wood, or even cork, care being taken that the cylinder revolves truly and is not given to wobbling. Any orifices remaining should be filled up. This may be done with sealing-wax, or with plaster of Paris coated with a film of sealing-wax or varnish. It is better to fill up in this way than to force in unduly a number of wedges, there being in the latter case a considerable risk of fracturing the cylinder. Should it transpire that the adhesion of the cement is insufficient to overcome the tendency of the spindle to run round without the cylinder, notches may be filed across the ends of the projections (A B, Fig. 2) and filled with the cement. This will be quite sufficient for such a machine as the one under consideration. The end faces of the cylinder should be coated with ceiling-wax varnish for insulating purposes, that is to prevent the electricity escaping from the surface of the cylinder to earth by way of the handle. The varnish may be made by dissolving *good* sealing-wax in methylated spirits, or shellac varnish may be made in a similar way, and a red colour imparted by the addition of a small quantity of vermilion. The rubber, or that portion which produces the friction with the glass, is easily made. Procure

XUM

(from a draper's, if unable to obtain them more easily) two wooden rollers, five to six inches in length and two inches or thereabouts in diameter. Round off the ends of one of these pieces and plane it down longitudinally, so as to form a flat face, and cover this loosely with a piece of soft leather, filling it out with a quantity of horsehair (or other convenient material) to form a pad. Along one edge of the pad sew a piece of silk four and a half inches long and an inch and a half wide, and along the other edge another piece of silk about the same width but about four inches long. The short piece forms the actual rubber, and the long piece the flap which rests on the upper half of the cylinder. On the under side of the roller (nearest where the silk rubber is attached) bore a hole, half an inch in diameter, and an inch or so deep, and fix in it a piece of half-inch glass rod about four inches long. Next, with the aid of a little flour paste, cover the remainder of the roller evenly with tin-foil. Let the free end of the glass rod be inserted in a half-inch hole bored in another piece of wood. The latter piece is shown in section in Fig. 6. In the upper portion, C D, which may be round or square, the hole A is bored, and the glass rod fitted. The lower portion, B, should be a quarter of an inch thick, an inch wide, and an inch long. Through the centre a hole, a quarter of an inch in diameter, should be bored. This tongue should fit, and work between the similar tongues, B C, in another piece of wood (illustrated in Fig. 5), which also measure a quarter of an inch thick, by an inch long, and an inch wide. Quarter-inch holes being bored through them, a solid pin, an inch long and a quarter of an inch in diameter, should be passed through the three holes, the result being that the glass rod can be worked to and fro at pleasure. The combination is shown sectionally in Fig. 4, where A B is a portion of the base, C the combination of tongues, the lower portion of the bottom piece of wood being screwed to the base from the under side. The plane of motion of the rod G should be at right angles with the spindle, so that the rubber which surmounts the rod may be moved to or from the cylinder. A small pulley (P, Fig. 4), say, an inch in diameter, is fixed by means of a piece of wood or stout wire, W, to a convenient part of the base (under the cylinder), and a half of a cotton-reel, R, is screwed on to the base between the pulley and C. A piece of stout silk-thread, S, is then tied round the glass rod, passed over the pulley, round the reel, and secured in a notch in the rim of the latter. The object of this arrangement is to afford facilities for adjusting the pressure of the rubber against the glass as it revolves. This object can also be attained by increasing the length of the glass rod and attaching the upper part of the collar (C D, Fig. 6) to the base by means of a hinge. The position of the hinge will be apparent. Either of these plans will be found preferable to the ordinary method of screwing the rubber forward from the top of the glass rod.

All that now remains to be provided is that part known as the prime conductor. For this, use the wooden roller above referred to, rounding off the ends so as to remove any sharp edges or points. Then bore in the middle of its length a hole half an inch in diameter and about an inch deep, fitting into a piece of half-inch glass rod about six inches long. The lower end of the rod should be fitted into another piece of wood screwed on to the base. The side of the roller nearest the glass should be furnished with a row of points, obtainable by cutting the heads off a number of pins and pushing them into the wood. The height of the prime conductor should be such that the pin-points are on the same level as the spindle.

The glass rods supporting the rubber and the prime conductor should be coated with a thin layer of shellac varnish, to prevent the electricity escaping.

In my next I shall deal with the question of working the machine, and shall detail a number of interesting experiments that can be worked with it.

## THE ORIGIN OF LANGUAGE.

By Ada S. Ballin.

I HAVE said in my essays on "Thought and Language" that the three chief theories of the origin of language are by no means so opposite as is generally supposed, but that it is quite possible that all are equally true. In point of fact, in the preceding series of articles, I have really set out a theory which includes them all, by demonstrating—1, the influence of emotional signs as a part of language (which forms the basis of interjectional theory); 2, the necessity of a system of signs as a means of communication (which, if I correctly interpret Prof. Max Müller's theory by saying that he maintains that man speaks of necessity just as a stone rings when struck with iron, is simply another way of stating that language is a response to a certain stimulus, one means of adapting man to his environment); 3, and lastly, how a purely imitative language, such as that of the deaf and dumb, may be naturally developed.

The great question which so exercised the minds of the ancients, as to why certain sounds (words) were first used to express certain things or ideas, is to a great extent answered by the theory of the natural origin of language, which I am in these articles endeavouring to explain. I believe that just as the origin of thought may be traced back to sensation, so the origin of language may be found in the outward manifestation of the same—in involuntary expressive gestures and sounds, and that these, being found useful, were voluntarily repeated as a means of communication. In co-operation with this purposive element was the imitative tendency, which I have shown to be so highly developed in those at a low stage of intellect. Thus emotional and imitative sounds become part of a system of communication, assisted, as we now find it among savages, by the natural sign-language, and it is also probable that certain sounds, originally uttered at random, in spontaneous exercise of the vocal organs, as among young children, were also affixed by convention to things and ideas with which they had no other relation.

It may be said that man having accidentally found that good resulted from his having given out some emotional sound or gesture, voluntarily repeats the sound or gesture as a means of communicating with his fellows. Having thus voluntarily imitated himself and found it useful to do so, he goes a step further and proceeds to imitate nature for a similar purpose, and as an aid to self-preservation. Thus it is that after all, the imitative faculties are the most important in the production of language, and this truth was evidently appreciated by Plato,* who puts into the mouth of Socrates the opinion that all names, whether primary or secondary, are intended to show the nature of things; and that the secondary derive their meaning from the primary. But how, he queries, do the primary names indicate anything? And then he asks the further trenchant

* "Dialogue Cratylus."

question: "Suppose we had no voice and tongue and wanted to communicate with one another, should we not, like the deaf and dumb, make signs with the hands, the head, and the rest of the body?" a question which he answers in the affirmative. "We should imitate the nature of the thing; raising our hands towards heaven would mean lightness and upwardness; heaviness and downwardness would be expressed by letting them drop to the ground; the running of a horse or other animal would be expressed by the most nearly similar gestures of our own frame. . . . The body can only express anything by bodily imitation . . . and when we want to indicate our meaning with the voice, tongue, and mouth, is not the indication of anything by means of them identical with their imitation of that thing?" Hermogenes admits the truth of the statement that the name is a vocal imitation of what is named; but then Socrates astonishes him by saying that they have not yet reached the truth, "because then we should be obliged to admit that the people who imitate sheep, or cocks, or other animals name that which they imitate." Here he falls into an error brought about by taking too limited a view of the case. To a certain extent it may be said that those who imitate animals name what they imitate; for if the imitation is good, a second person would at once recognise the animal imitated. But a distinction may here be drawn between those who imitate without having any intention of thereby communicating an idea and those who imitate with the set purpose of naming with the desire of communicating. The former class may be said not to name, while the latter class are certainly naming. Hence the first position held by Socrates was perfectly tenable, the quibble being evidently raised for the purpose of introducing a second proposition which he seems to have considered incompatible with the first, although, as we shall see, the two are by no means opposed to each other, but probably represent co-operating agencies.

Still, through the mouth of Socrates, Plato goes on to propound the theory that the essences of things are expressed in letters and syllables, which must be classified and analysed in order to understand how the ancients, or, perhaps, the barbarians who preceded them, formed language. Thus he thinks motion is generally indicated by the sound R, because in its pronunciation the tongue is most agitated. "Ph," "ps," "s," and "z," are used to imitate such notions as shivering (*psuchron*), seething (*zéon*), to be shaken (*seisthai*), when it is required to imitate what is windy. The closing of the teeth and pressure of the tongue in pronouncing "d" and "t" give an idea of binding and rest in a place, the liquid movement of "l" that of smoothness, as in level (*leios*). "N" sounded from within gives a notion of inwardness, "a" expresses size, "o" roundness, and "œ" (*η*) length. Here Plato shows a keen appreciation of the physical aspect of the case, as, for example, in pronouncing "a" (sounded "ah") the mouth is at its largest capacity, in "o" the lips are rounded, and in "*η*" (the sound in pale) they are lengthened out. Laying further stress on the idea that the name signifies the nature of the thing, he continues:—"If the name is to be like the thing, the letters out of which the first names were composed must also be like the things."

Socrates considers that words were made by the legislator, and so constructed as to express the nature of things; but this is to attribute a degree of conscious—voluntary action—of deliberate choice and selection to primitive men which is inconsistent with modern views of their mental development. The greater probability is that the imitation of natural sounds was purely involuntary, and brought about simply by the fact that they suggested themselves, by being ready for use. Thus, animals get names from the sounds they make, and thus emotional cries are repeated to recall the feelings in which they originated. By a further step, also, just as I have shown that the deaf and dumb, and others who communicate by means of manual and physical signs, make movements corresponding in character to the aspects of the things signified, so by analogy harsh and difficult sounds are used in naming unpleasant objects and ideas, while those easy to pronounce are adopted for pleasing things and concepts.

The theory of the origin of language by imitation has, as I have already said, been called the *onomatopœtic* or *name-making* theory (Gr. *onoma*, a name, and *poièô*, I make), itself a most inexpressive name; its meaning is, however, so well known that it serves as well as any other: for the origin of a word is of little importance provided its present meaning is understood. This is the chief reason why the origin of language is so obscured, for, as I shall show, owing to various circumstances the forms and meanings of words are so changed in the course of years that their original conditions can only be determined with great difficulty. A word having once been adopted, there is no limit to the changes that may be effected in it in accordance with the physical and mental constitutions of the speakers—changes which are accepted by convention: it is, therefore, most unphilosophical to assert, as so many authorities have done, that language could not have had an imitative origin because so few of the words now in use are apparently imitative.

The changes which take place in language are exhaustively classified by Whitney as follows:—*

I. Alterations of the old material of languages. Change of words which are retained as the substance of expression, and this of two kinds or sub-classes:—1. Change in uttered form. 2. Change in content or signification, the two, as we shall see, occurring either independently or in conjunction.

II. Losses of the old material of language, disappearance of what has been in use; and this also of two kinds: 1. Loss of complete words. 2. Loss of grammatical forms and distinctions.

III. Production of new material; addition to the old stock of a language in the way of new words or new forms; external expansion of the resources of expression.

I.—1. Changes in the uttered form of language are largely caused by racial and individual peculiarities in the vocal organs. No two people pronounce any word exactly alike, although the difference is frequently so slight that the ear can hardly detect it; but the difference has a very good reason in the greater or less divergence in the physical constitutions of the speakers. We all know persons who cannot pronounce the letter *w*, others who substitute *w* for *r*, and others again to whom the English sounds of *th*, either as in *that* or in *both*, are insurmountable difficulties. The last two sounds, which are unpronounceable to but few English people, are almost beyond the powers of the French or German nations; while the German *ch*, as in *ach*, is rarely mastered by an Englishman, and the French *r*, as in *grasseyer*, hardly ever. Of the fifty-six elementary sounds known to students of phonetics, many European languages are deficient in fifteen or twenty.

* "Life and Growth of Language." 1879. P. 44.

French has almost entirely lost the sound of *h* as we have it in English, and that that sound is by no means secure in our own land is proved by the 'Arry "'oo 'opes you're very well," and the M.P. who talks of his work "in the *'Ouse*." The Aztecs have no sounds *g, d, b, f, h*. Although Hebrew and Arabic are so nearly allied, the sound of *v*, which is common in Hebrew, is unknown in Arabic, while the Arabic initial *w* does not exist in Hebrew. To take another example, there exist in Arabic no less than eight sounds which few, if any, Westerns can ever master, and then only after years of practice.

A sort of natural selection of sounds takes place, an unconscious selection governed by physical peculiarities, which, in their turn, are greatly modified by climate and social conditions. Thus the hardy races of the North have a language largely composed of harsh, rough sounds, in the pronunciation of which much energy is expended. In the luxurious south, however—as, for example, in Italian—the sounds are soft and easy to pronounce. Again, dwellers in thinly-populated districts, who are not driven to talk much, pronounce slowly and carefully, while those who dwell in cities, and who are of necessity great talkers, clip their words, slur over difficult sounds, and even drop them altogether.

These common and everyday sound-changes which are unnoticed in our ordinary intercourse with our fellow countrymen at once become apparent when we converse with Americans, whom we cannot always understand, although their language is our own. So striking are these changes, that in the introduction to his celebrated "Biglow Papers," Mr. James Russell Lowell considered it necessary to make a detailed explanation to his readers, lest they should fail to understand the language he puts into the mouths of his Yankee heroes. He says :—

1. The genuine Yankee never gives the rough sound to *r* when he can help it, and often displays considerable ingenuity in avoiding it even before a vowel.

2. He seldom sounds the final *g*—a piece of self-denial, if we consider his partiality for nasals. The same of the final *d*, as *han'* and *stan'* for *hand* and *stand*.

3. The *h* in such words as *while, when, where*, he omits altogether.

4. In regard to *a* he shows some inconsistency, sometimes giving a close and obscure sound, as *hev'* for *have, ez* for *as, thet* for *that*, and again giving it the broad sound it has in *father*, as *hânsome* for *handsome*.

5. To the sound *ow* he prefixes an *e* (hard to exemplify otherwise than orally).

The following passage in Shakespeare he would recite thus :—

> Neow is the winta uv eour discontent
> Med glorious summa by this sun o' Yock,
> An' all the cleouds thet leowered upun eour heouse
> In the deep buzzum o' the oshin buried;
> Neow air eour breows beound 'ith victorious wreaths;
> Eour breused arms hung up fer monimunce;
> Eour starn alarums chänged to merry meetins,
> Eour dreffle marches to delightful measures.
> Grim-visaged war heth smeuthed his wrinkled front,
> An' neow instid o' mountin' barebid steeds
> To fright the souls o' ferfle edverseries,
> He capers nimly in a lady's chämber,
> To the lascivious pleasin' uv a loot.
>
> *Richard III. Act.* 1, *sc.* 1.

The substitution of one sound for another may be either (1) from a defect of hearing, which may be compared to colour-blindness; or (2) from defect of the vocal organs; or (3) from defect of the nervous mechanism supplying them; or (4) from carelessness. The child who, when I said to him "Can't you say *rope?*" indignantly replied, "Well, I did say *wope!*" was probably affected by the first of these alternatives; and the same is most likely true of the Polynesians, who turned *Samuel* into *Hemara*, and *David* into *Raviri*.

Similarly when young children are learning to speak, the same word takes on quite different forms in different mouths. Thus the word *water* is pronounced by one *ga-ga*, while another utters it *wa-wa*. *Milk* is referred to by one as *wuk*, while another tiny autocrat lustily demands his *mu*, and so on.

In the Malayo-Polynesian group of languages the word *oran, man*, becomes in different dialects *rang, olan, lan, ala, la, na, da*, and *ra*. Unconscious changes of this kind are the great cause of the divergence of dialects from a common language, and, by continued differentiation, of languages from a common stock; and Whitney does right in giving it the first place in his classification. Of this differentiation I propose to speak next month, but I would here remark that of the possible number and combinations of sounds, comparatively few are utilised. Prince Lucien Bonaparte has made a list of 385 sounds, seventy-five of which are vowels, which may be articulated; but many of these are not found in any known language or dialect.

The number of possible combinations of sounds which might be used as words has been calculated as follows by Mr. Pagliardini. Allowing that forty-eight elementary sounds may be produced by the human vocal organs, taking these

| | |
|---|---|
| 2 by 2 gives ..... | 2,256 |
| 3 „ 3 „ ..... | 103,776 |
| 4 „ 4 „ ..... | 4,669,920 |
| 5 „ 5 „ ..... | 205,476,480 |

so that a monosyllabic language containing no word with more than five letters could theoretically possess 210,252,488 words; but as some combinations—such as those in which no vowels occur, as, *dtms, rsfn*—could not be pronounced, this number may be reduced to one hundredth part, that is to two millions, which would still be a larger number than the sum total of all the words in all the languages of Europe.

The laws of phonetic change are partly those of the physical relation of articulate sounds, but partly influenced by human will—aversion to certain efforts, choice of particular forms, sense of euphony and proportion, and all the thousand motives which influence human action.

Every law of speech has its origin in the physical and mental constitution of the users of speech, in their capacities, necessities, likes and dislikes, in their circumstances, natural and historical, and in their inherited and acquired habits.

Owing to the manner in which languages grow and decay, there has been a great tendency to regard language as a living organism, but this is mere mythology. Languages are the slowly-elaborated products of the application by human beings of means to ends, the result of the devising of signs by which ideas may be communicated, and the operations of thought carried on. Language may, therefore, rather be compared to a building, each individual brick of which has to be made and proved worthy before it can be added to the noble pile. Every item of speech had its beginning either in accident or design, and whether it maintained itself and obtained currency depended on whether it supplied a want.

## THE BOOK OF GENESIS.

WITH SPECIAL REFERENCE TO THE IDEAS OF MEN IN OLD TIMES ABOUT THE SUN, MOON, AND STARS.*

By Richard A. Proctor.

IF Dr. Payne Smith's Commentary on the Book of Genesis, regarded as a contribution either to religious literature or to Exegesis (to use a somewhat affected technicality) I propose to say little here. It presents, as does his introduction to the Pentateuch, that singular mixture of profound learning in regard to details of ancient history and literature, with childlike and bland acceptance of the literal meaning of passages which would be absurd if not allegorical, which characterises so many of these works. One cannot help liking the *naïve* simplicity of the teaching, or feeling that for babes and sucklings it must really be very nice and may even be very nourishing (however unfit for grown folk). When we read that "the demeanour of Adam is extraordinary," that "Eve was more quiet and observant," that "Adam had little sense of responsibility" (rather hard on us by the way), but "the woman's answer was far nobler," while "the serpent stood there without excuse" and therefore "was condemned to crawl" though probably it had not "even originally, been erect and beautiful," nor probably had "Adam tamed serpents and had them in his household," as some fondly imagine—one wonders for what sort of children (five, ten, or twelve years old, or what?) the kindly doctor's commentary is really written. Then again, though this is going back a page or two, "they heard the voice of the Lord God walking in the garden"; "really," says Dr. Smith, "this is in admirable keeping with the whole narrative; and Jehovah appears here as the owner of the Paradise, and *as taking in it His daily exercise;* for"—the quality of this reason is exquisite; *for* the verb is in the reflective conjugation, and means 'walking for pleasure.'" (The Infinite taking a constitutional!) This, though it corresponds well with the rather puerile quality of the scientific excursions of the reverend author, sounds oddly in company with the really sound and instructive remarks on linguistic, historical, and exegetical matters. One is reminded of the curious combination of learning and simplicity in the old Greek and Latin school-books,—where profound knowledge of linguistic details is found in company with utterly childlike innocence of the ways and wants of young learners.

Only on one point need we be at all severe with a book of this bland character. Dr. Smith makes the remark, utterly erroneous, though no doubt he imagines it true, that "the unwise disputes between science and theology almost always arise from scientific men crying aloud that some new theory just hatched is a disproof of the supernatural, and"—this is right enough no doubt—"from theologians debating each new theory on the ground of Scriptural exposition." I venture to say that *not a single dispute* between science and theology *has ever arisen* from scientific men proclaiming anything in regard to the bearing of new theories, or even of established truths, on belief in the supernatural. The theologians may safely be defied to cite a solitary example of that which Dr. Smith describes as occurring *almost always* in such cases. *Invariably*, I believe, (*almost always*, I am certain,) the man of science with a new discovery, or a new theory, or a new truth, has had no thought or care about its bearing on the supernatural; he has never cried aloud, or thought of crying aloud, about anything of the sort; *but*, when he has indicated his discovery, or theory, or new truth, some watchful theologian has been ever ready to proclaim, "Oh, we can *not* admit this, it is inconsistent with what we have been teaching"—and later when a truth has been established "Oh, that is no new truth, it has been implicitly involved in our teaching from the beginning,"—forgetting later still that they had started the dispute.

It would seem as though, having had so often to follow this not very dignified course, the weaker theologians had rather lost temper, and like the losing player in a well-known story had been moved to kick the first they came across. The kicked in that story was attending, like the student of science, to his own business—tying his shoes, in fact; but, when he urged this, the angry loser said, not quite truthfully, "You're *always* tying your shoes in my way."

I propose, however, to consider the book before me from the scientific standpoint,—and therefore say no more about its qualities as a religious treatise, except to remark that the tone of the general introduction, from the pen of my much-esteemed teacher in divinity in old King's College days, Dean Plumptre of Wells, is in my judgment admirable. His remarks on the mechanical theory of inspiration are excellent; and his opinion is undoubtedly just that were such a theory accepted we must accept along with it the necessity of an infallible interpreter of an infallible book,—a circumstance which gives to the Roman Church its essentially logical standing-ground. On the other hand, what has been called the dynamical theory of inspiration is open to no such objection. This theory undoubtedly adds immensely to the value of these ancient records regarded with reference to the light they throw on the history, science, literature and religious ideas of ancient times.

As a matter of fact the older books of the Bible, and even some of the later, ought to be of great interest to all men, outside of the religious value we may assign, or decline to assign, according to our lights, to these works. To one who accepts the doctrine of absolute verbal inspiration, it should manifestly be a matter of interest to inquire what has been said, under such favourable conditions, about scientific as well as about other subjects. To the man who regards the Old Testament as a revelation in the same sense only in which we call it a testament,—viz., in so far as it bears witness of God's will and purposes towards man,—it must be interesting to note what views were held on outside subjects by writers selected to communicate God's plans to their fellow-men. And to those who, like many of the most learned Jews of the present day, regard the ancient Hebrew Scriptures only as presenting an exposition of the views of the ablest and wisest men of the ages in which its various books were composed, it is necessarily a matter of interest to inquire what the Hebrews knew, or thought they knew, about scientific matters.

For my own part, I view with interest all that relates to science in ancient writings, Assyrian, Egyptian, Hebrew, or Indian. I can not only see no reason why the passages relating to scientific matters in the Bible should not be studied in precisely the same way that we should study similar passages in Homer or Hesiod or Herodotus, but I find something of absurdity in the idea that *because*, as many hold, such passages must be pre-

* *The First Book of Moses called Genesis*, with Commentary by Dr. R. Payne Smith, Dean of Canterbury, an Introduction to the Pentateuch by the same writer, and a General Introduction to the Old Testament by Dr. E. H. Plumptre, Dean of Wells; Edited by Dr. Elliott, Bishop of Gloucester. (Cassells & Co., London.)

cisely true in every detail, therefore they ought *not* to be examined like writings which may perchance contain error. If thus true, these passages must give just the sort of information (be the amount greater or less) which science requires; if by any possibility they are erroneous (or have been erroneously interpreted), then we should adopt such a modified view of the doctrine of inspiration as will save us from the grievous mistake of attributing error (or imperfect expression of truth) to the All-Wise.

It is tolerably clear to any one who reads the first chapter of Genesis that, apart from any question of a religious revelation partially involved or implied in it, there is, underlying the whole narrative, a certain system of science. We can indeed only form a brief abstract of the science of those days from this remarkable account. For it seems to have been part of the writer's plan to avoid details as far as possible; as though he felt that, while it was impossible to speak otherwise than in harmony with the science of his day, it would be better to avoid statements too definitely in accordance with scientific views which might in after ages be corrected. Still the writer was manifestly well acquainted with the accepted scientific views of his day.

Consider, for instance, the sixth and following verses of Genesis i. We know that even to a much later age than that of the original authors of the book of Genesis (in its present form it is undoubtedly a revision and in part a compilation, as Dean Plumptre points out in the work before us) the idea was entertained that a solid partition of perfect transparency separates the waters of the sea from that store of waters above whence clouds and rain proceed. That the sun raises the vapour of water from the sea, and that this vapour becomes condensed into cloud, whence, under particular conditions, rain falls, would doubtless have seemed to them a wild and fanciful notion. Accordingly, in the ancient Assyrian cosmogony, of which fragments have been found in baked clay tablets, we recognise traces of the meteorological ideas which remained prevalent until men discovered the true interpretation of cloud and rain. The Assyrian record is far older, or at least presents ideas belonging to a far older time, than that of the writer of the Elohistic narrative in the Book of Genesis; for Sayce and Smith have traced the origin of the clay tablet literature to the Akkadians, an older race than the Assyrians, or even than the early Babylonians. (Some of the Babylonian tablets are fully a thousand years older than Assyrian copies.) But the Hebrew account, while in harmony with the science of its time, is carefully freed from definite error.* It runs thus, "and Elohim" [lit. the Powers, equivalent to Spencer's Infinite and Eternal Energy] "said, Let there be an *expanse* in the midst of the waters, and let it divide between waters and waters. And Elohim made the expanse, and divided between the waters which were beneath the expanse and the waters which were above the expanse; and it was so. And Elohim called the expanse 'Heaven.'" For "expanse" the real meaning of the Hebrew word in this account, the Septuagint has στερέωμα, which really means "a solid body"; the Vulgate has "firmamentum" which also definitely implies solidity; and both the authorised and the revised English versions have the word "firmament," which only fails to be similarly definite because it has now lost its primary significance and is understood in its applied sense only. Milton was the first to use the word "firmament" in this erroneous sense, where he sang of "the Firmament, expanse of liquid, pure transparent elemental air"; but as he knew well that the original Hebrew really signified "an expanse," which might or might not be solid, so also he knew perfectly well that the word "firmamentum" meant something not only solid but rigid. It may be said that the original Hebrew narrative, in another place, implies that the expanse was really solid; for in describing the flood, it says that "the floodgates of the heaven were opened," as though that part of the water which came from above the expanse were let out through openings in some solid partition: but we may fairly regard this as poetical. (It is followed by words which are certainly poetical; for the words translated "in the self-same day," which in the Elohistic narrative follow immediately after the words relating to the floodgates of heaven, really signify "in the *bone* of this day.")*

Compare, again, the Hebrew and the Assyrian accounts of the sun, moon, and stars. The Assyrian account is unfortunately not quite complete, but from what remains of it we see that not only was it mixed up with much belonging to some ancient system of Sabaistic worship, showing its superior antiquity (for polytheism long preceded monotheism); but it was full of details relating to the (erroneous) scientific ideas of the times to which it belonged. It ran thus:—

I. All that was fixed by the great gods (probably akin to the plural form Elohim, and not *necessarily* implying more gods than one, any more than that form does) was good.

2. He (Elohim, understood in the rest of the account as one god) arranged the stars in figures of animals.

3. To fix the year through the observation of their groupings.

4. He arranged twelve monthly signs of stars in three rows (qy. in sets of three, *i.e.*. to correspond to the four seasons—three signs to a season).

5. From the day when the year commences unto the close.

6. He marked the positions of the wandering stars (that is, of the planets) to shine in their paths,

7. That they may not do any injury, and may not trouble any one. Manifestly that they may not injure each other, or come into collision; for in the Assyrian system of astrology the malign influences of some of the planets were clearly recognised—so that they were certainly not supposed incapable of doing any harm to men and animals.

8. The position of the gods Bel and Hea (Jupiter and Saturn) he assigned

9. And he opened the great gates in the darkness shrouded

10. The fastenings were strong on the left and right

11. In its mass (that is, the lower chaos) he made a boiling

12. The god Uru (the moon) he caused to rise out, the night he overcame

13. To fix it also for the light of the night until the rising of the day

14. That the month might not be broken, and might be regular in length.

* Dr. Payne Smith and many other theologians entertain as possible the most unlikely doctrine, that the account in Genesis is an older version (of which Abraham had a copy, says Dr. Smith, *naïvely*) in his clay-tablet library, which he probably carried with him when he left Ur for religious reasons. The fact that it has been freed from polytheistic ideas proves it to be more recent than the Assyrian version.

* Compare Job xxvi. 2, and xxxvii. 18; 2 Samuel xxii. 8; Psalms lxxviii. 23.

15. At the beginning of the month, at the rising of the night,

16. His horns are breaking through to shine on the heaven.

17. On the seventh day * to a circle he begins to swell.

18. And stretches towards the dawn further.

19. When the god Shamas (the sun) in the horizon of heaven, in the east

20. . . . . formed beautifully . . . .

21. . . . . to its orbit Shamas was perfected . . . .

The rest is lost, though it may hereafter be recovered; for it is known that several copies existed of this ancient work.

In the Assyrian account there is, of course, much which is definitely inconsistent with modern science. We do not imagine that the stars were purposely arranged in figures of animals. We cannot recognise the planets as having their paths assigned to them with reference to the wants of our earth; and we should certainly not admit the possibility that our moon was sent out through the great gates enclosing the lower chaos, and there and then started (as it were from out the ribs of mother Earth), along that course whence she shines, for a few days in each month, as "the light of the night until the rising of the day."

The account in Genesis is free from these defects. It runs simply,—"And Elohim said, 'Let there be lights in the expanse of the Heaven to divide between the day and the night, and let them be for signs and for seasons, and for days and years; and let them be for lights in the expanse of the Heaven, to give light upon the Earth; and it was so. And Elohim made the two great lights,—the greater light for the rule of the day, and the lesser light for the rule of the night,—and the stars. And Elohim *gave* them in the expanse of the Heaven, to give light upon the earth, and to rule over the day and over the night, and to divide between the light and the darkness; and Elohim saw that it was good."

All this, while in perfect harmony, and clearly meant to be in harmony, with the ideas which prevailed in old times respecting the heavenly bodies, is yet not necessarily inconsistent with our modern knowledge. We may interpret the account as we interpret the words "The Heavens declare the Glory of God, the firmament showeth his handywork," which no one thinks of taking literally. It may be true that we cannot accept the account as it was understood till comparatively recent times. Knowing the stars to be orbs exceeding our earth hundreds of thousands, nay—some of them—millions of times, in volume, and severally representing energies compared with which all terrestrial things described in the first chapter of Genesis are as a grain of sand compared with the earth's mass, we cannot (if we accept the Bible account) understand it to signify that the stars were individually made and set in the expanse of heaven for no other purpose but to give light to the earth. We know, indeed, that multitudes of the stars which actually exist, probably millions for each visible star, are not lights in the heavens at all. But we may take the Bible account as telling those for whom it was written that the sun and moon, and all the stars which are as lights in our heavens, which serve therefore for signs and seasons and for days and years, are God's work, and therefore are not to be worshipped as the Egyptians and Assyrians worshipped them. Nor, while thus free from a peevish precision in our interpretation as relating to space, need we be unduly exacting in regard to time, either as to duration or as to sequence. To understand a day's work, a second day's work, and so forth, too literally in either respect, is in reality as absurd as it would be to understand God's "handywork" as something fashioned with hands such as men have. All that the account of the heavenly bodies in Genesis need be regarded as really implying is that God made those heavenly bodies which are so useful to us,—and that in the host of heaven we see *another* (a fourth, it chances to be in the narrative) of the great works of His Hand. This rightly understood, and apart from Anthropomorphic interpretations which are inherently absurd, is the teaching of Science also.

* This corresponds with my theory that the week was originally measured by reference to the half-moon phase—much more exactly determinable than the time of full moon.

## MISPRONUNCIATION.

[COMMUNICATED.]

MR. ALEXANDER'S letter (1889, KNOWLEDGE, p. 185) interested me much. I give now a few more examples of words in common use amongst natives of India, but derived from English:—Colonel, ker-r-r-nal; captain, kaptán; commander, kamáneer; butler, bootrail; cupboard, kappát; glass, gilás; American drill, Merikanderil; bottle, bátli; flannel, falánin; cap, kep (*i.e.*, percussion-cap); cartridge, cartoos; pistol, pistól; line, lahin; fall in, fálin; port arms, pote ar-r-rms; unfix bayonets, un*ph*ix bagnet (ph has not quite the sound of f as with us, the p is slightly sounded); shoulder arms, chodar arms; present arms, pharjant arms; bugle, beagle; box of matches, phire bokkus; doctor, dáktar; first assistant, phasht ashishtant; barrister, bálister; engineer, ejnair; library, laibri; class, kilás; lash (of a whip), lásin.

Here are some of the terms our butlers (bootrails) use:—Sponge roll (pudding), ispaurol; beefsteak, beebishtake; devilled mutton, double mutton; poached egg, pochuck; potato, batátá; claret, kilárat.

Here the names of some of my dogs with their native equivalents:—Drake, Rake; Ruby, Luby; Daisy, Lazy; Lena, Reena; Panther, Painter; Sambo, Shumbhoo (name of a Hindu god); Scamp, Iscámp; Demi (short for Democrat), Dammy; Toby, Topu (Hindustani for "a hat"); Growler, Girowe.

And here the names of some of my friends and acquaintances:—Ashburner, Arsbrune; Beaman, Beeban; Booth, Boot; Cox, Cokkus; Crawford, Crápat; Fenton, Phintan; Gleig, Gillick; Macnaghten, Megnátan; Peile, Pill; Philip, Pillick; Scott, Ishkát; Swetenham, Soolteen. (Note.—á = a in calm, palm; a = u in tub; u as u in tub; ú as oo in boot; *e.g.* crápat = *crá*, as in craft, and *pat* as put in Putney.)

Mr. Alexander might have added lakri (stick) as a word always mispronounced by uneducated Europeans as "lackry."

He is wrong in spelling it "gháriwán"; there is no h in gári (cart or carriage).

I have heard tourists speak of Allahabad as Allerabad; and of Delhi as if it were Delhigh (as *high* tree, hill, mountain, &c.).

Káthiáwán, India, Sept. 22, 1885. C. F. G. LESTER.

DARWIN AT CAMBRIDGE.—Mr. Grant Allen, in his admirable Life of Darwin (which will be reviewed by a kindred mind in next month's KNOWLEDGE) remarks that "fortunately for us, Darwin did not waste his time at Cambridge over the vain and frivolous pursuits of the Classical Tripos." A critic in a daily newspaper questions the taste and the English of this remark. The English rightly understood (as a University man would at once understand it) is sound enough. Of the remark itself something more may be said than that it is in good taste. It is well said! It tells a truth that much needs telling. When we think how many men that might have done useful work have been turned into mere word-mongers, doing nothing by which knowledge may be increased though some at least among them might have done much, we feel that the thought cannot be too plainly put or too often recalled. So with Mr. Allen's remark about Darwin's escape from Plato and Aristotle, and the useless—almost meaningless—mysteries of *Barbara* and *Celarent*, which might (Mr. Allen says "infallibly would") have overwhelmed him had he been an Oxford man. A little plain speaking about such matters is very much needed—and good service can never be bad form.

XUM

# Our Chess Column.

By Mephisto.

## STEINITZ V. ZUKERTORT.

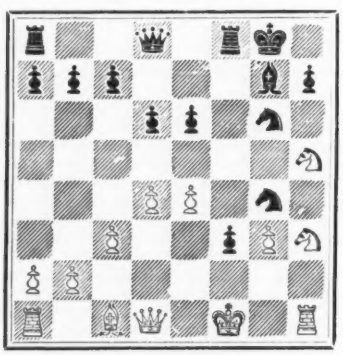
THIRTY-FIVE years ago, the late Professor Anderssen, of Breslau, won the first International Chess Tournament, organised at the time of the first International Exhibition. This victory won him the well-deserved reputation of champion player of the world. In 1858, there appeared, meteor-like, Paul Morphy, who, aided by his phenomenal genius for the game, defeated every player he met, including Anderssen. Morphy's reign over his Chess kingdom was unfortunately but brief. In 1862, we again see Anderssen coming to the fore, by winning the second London International Tournament. One of the competitors in that tournament, Wilhelm Steinitz, then came to the front, and, in 1866, he dethroned Anderssen by defeating him in a set match, of which, we believe, the result was—Steinitz 6, Anderssen 4. About the year 1870, Zukertort appeared in the Chess arena in England. In 1874, Zukertort engaged in a match with Steinitz, but the latter won by seven games to one. In 1876, Blackburne boldly threw down the gauntlet, and challenged Steinitz; but he met with even a worse fate than Zukertort. Steinitz won every game of the match.

Steinitz's title to be regarded as the Chess Champion of the World was not questioned until a few years afterwards. Zukertort, who claimed to have defeated Anderssen, also defeated Rosenthal and Blackburne in set matches, the former by seven to one, and the latter by seven to two. Of course, these two matches could not affect Steinitz's position; nevertheless, Zukertort had some fair grounds for claiming that title after the London Tournament of 1883. Although we are not at all inclined to believe that anything but a personal encounter could decide the claim of one player to be considered the Chess Champion in preference to another, especially if he has previously been defeated in a match by him; yet we must admit that not only was the London Tournament an exceptionally strong one, but the feat accomplished by Zukertort in winning the first prize, he only losing one game—being three games ahead of Steinitz—was an unequalled success, fully entitling him to the highest honours in Chess. Since that time the Chess world in general, and Steinitz in particular, wished to see a combat between these two Chess Titans. At the present moment there are fair prospects of a match taking place in America, between Zukertort and Steinitz, to decide which is the better man. The match will be for £400 a side for the first ten games, and there can be no doubt that it will eclipse in point of interest any previous combat of the kind. Whichever of the two players loses will not be disgraced, for both players have attained the highest rung on the Chess ladder, and their reputation will live on their numerous and brilliant successes of the past, as well as their analytical labours, which latter have largely contributed towards modelling modern Chess theories.

We think it will be of interest to our readers to give some specimens of the previous play between these two masters.

Position at the 18th move of a game played between Steinitz and Zukertort in 1872.

Zukertort—Black.



Steinitz—White.

White continued the game with—

| | |
|---|---|
| 19. Kt to Kt5 | B to R3! |

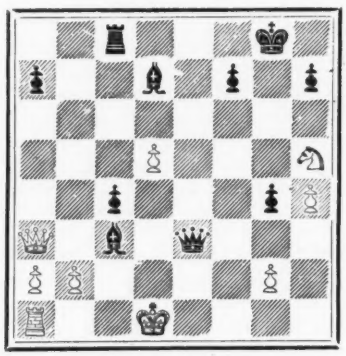
A subtle move, to which White makes an equally good reply. Black would win if White accepted the bait of the exchange, for after 20. Kt × P, B × B! 21. Q × B (best), Q to K2; 22. Kt × R, Q × P; 23. Q to Q2, P to B7; 24. R to R3, R × Kt, Black has the best game.

| | |
|---|---|
| 20. Q to Kt3! | B × Kt |
| 21. Q × P (ch) | R to B2 |
| 22. Q × Kt (Kt4) | B × B |
| 23. R × B | Q to K sq. |
| 24. P to B4 | P to Q4? |
| 25. P to K5 | P × P |
| 26. R × P | Q to Kt4 |
| 27. P to Kt3 | Q to B3 |
| 28. Kt to B6 (ch) | R × Kt |
| 29. P × R | Q × P |

30. R × P and White won.

Position after the 22nd move of a game played in the Vienna International Tournament of 1882.

Zukertort—Black.



Steinitz—White.

The game terminated as follows:—

23. P × B.

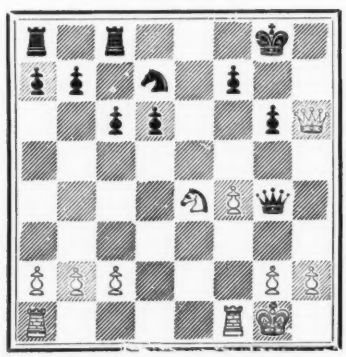
Obviously White cannot play Q × B, on account of B to R5 (ch).

| | |
|---|---|
| | Q to Kt8 (ch) |
| 24. K to Q2 | Q × P (ch) |
| 25. K to K3 | R to K sq. (ch) |
| 26. K to Q4 | Q to K5 (ch) |
| 27. K to B5 | Q to K2 (ch) |
| 28. P to Q6 | Q to K4 (ch) |
| 29. K × P | Q to K5 (ch) |
| 30. K to Kt3 | R to Kt sq. (ch.) |

and Black won.

Position after White's 21st move of a game played in the London Tournament of 1883.

Steinitz—Black.



Zukertort—White.

Black continued with—

| | |
|---|---|
| 21. | Q to E4, |

Much better than P to Q4. If Kt × P, Q to B4 (ch)!

| | |
|---|---|
| 22. QR to K sq. | R to K sq. |
| 23. R to K3! | R × Kt |

A brilliant attack on the part of White; he gains the exchange, but puts his Q out of play.

| | |
|---|---|
| 24. R to R3 ! | Q to B3 |
| 25. Q to R7 (ch) | K to B sq. |
| 26. Q to R8 (ch) | K to K2 ! |
| 27. Q × R | Q to Q5 (ch) |
| 28. K to R sq. | R × P |
| 29. R to K sq. (ch) | |

This was bad; R to KKt sq. was the correct move.

| | |
|---|---|
| | R to K5 ! |
| 30. R × R (ch) ? | Q × R |
| 31. Q × RP | |

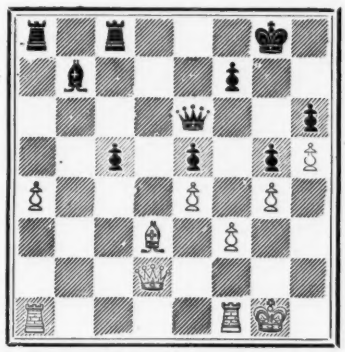
Curiously enough, White cannot prevent the mate, except by giving up his R

P to Kt3

Resigns.

POSITION AFTER THE 31ST MOVE IN A GAME PLAYED IN THE LONDON TOURNAMENT OF 1883.

ZUKERTORT—BLACK.



STEINITZ—WHITE.

In this difficult position, Zukertort won by very good strategy. White played—

| | |
|---|---|
| 32. KR to Kt sq. | P to B5 ! |

If, now, White plays—33. R × B, Q to Q3 [threatening Q to Q5 (ch)]; 34. R to Q sq., R to Q sq., Black gets a well-advanced and provisionally-protected passed Pawn, while White's QRP is weak. Nevertheless, we think that White ought to have simplified the game by playing 33. R × B, then, if Q to Q3, 34. R to Qsq, R to Qsq; 35. Q to K3, P × B; 36. R to Kt3, P to Q7; 37. R to Kt2, Q to Q5; 38. K to B2, and the game ought to be drawn.

| | |
|---|---|
| 33. B to B2 | P to B6 ! |
| 34. Q to K3 | B to R3 |
| 35. R to Kt6 | R to B3 |
| 36. P to R5 | QR to QB sq. |
| 37. K to B2 | Q to B5 |
| 38. B to Kt3 | Q to Q5 |
| 39. B to Q5 | R × R |
| 40. P × R | P to B7 |
| 41. Q × Q | P × Q |
| 42. R to QB sq. | P to Q6 |
| 43. K to K3 | R to Kt sq. |
| 44. P to Kt7 | K to Kt2 |
| 45. K to Q2 | B × P |
| 46. B × B | R × B |
| 47. K × P | R to Kt6 (ch) |
| 48. K × P | R × P |

and Black won. White would not have done much better if, instead of 48. K × P, he had protected the BP by K to K2; for Black replies with R to B6, and then brings up his K.

A FOOL DEFINED.—Erasmus Darwin defined a fool as "a man who never tried an experiment in his life." There is no escape from a definition like this, as there is from such a saying as J. S. Mill's "Every fool is a Conservative." Mill could logically say it did not follow that "every Conservative is a fool,"—which, let us hope, gave great comfort to the Conservative mind. We cannot, however, say that Erasmus Darwin's definition leaves even one out who never tried an experiment; for a true definition does not err either in excess or in defect. This definition therefore asserts that every man who has tried no experiment in his life is a fool, as certainly as it asserts that no fool ever tried an experiment.

# Our Whist Column.

## A PROTEST AGAINST SIGNALS.

BY MOGUL.

AS the one quality which gives Whist its greatest charm and favourably distinguishes it from Chess and Double Dummy is the exercise it affords of the faculty of reasoning from the known to the unknown, the introduction into the game of signals, which convey positive information without exercising the reason, cannot but be regarded as a great blot on, and as tending to lower the character of the game, and to make it less scientific; and Pole outrages one's common sense in calling modern Whist, when compared with the Whist of Matthews, Arnaud, Deschapelles, and others, the "scientific game," when, in fact, it is only the old really scientific game, with the addition of certain purely mechanical and unscientific dodges, for giving information known as signals. No wonder that Pembridge, in his last amusing and instructing brochure, "The Decline and Fall of Whist," which every Whist student should read, calls all the signals "wooden arrangements." The term is apt, as the veriest blockhead, after one explanation, can make and understand a signal as well as the most skilful player, for the very essence of a signal is that, by virtue of a previous convention, it conveys certain definite information, and so entirely does the meaning of a signal depend upon a prior convention, that two of the signals—viz., the Peter and the Penultimate—conveyed at one time different information to that now conveyed by them. Perhaps some readers of Cavendish will fancy that signals or conventions (for they are really synonymous terms) are extensions of principle; but they are nothing of the sort, and Cavendish's attempt to prove this is based entirely on unsound reasoning. If any one doubts it, let him carefully analyse Cavendish's chapter on the "Conversation of the Game," and he will be satisfied that the author misapprehends the meaning of the word "convention," and has false notions of what constitutes a principle, or else he would not talk of extending it as if a principle were something elastic. It cannot be too clearly understood that signals are conventional modes of conveying information and nothing else, and that players can easily invent as many of them as they like, *e.g.*, two, or more, players can agree that an original lead of a card of a different colour to the trump card should indicate a strong hand; that the lead of the smallest but one of a suit should indicate that the leader held an honour in it, that the present mode of calling for trumps should indicate a desire to be forced, and so on; and one can see how two players playing frequently together, and practising their peculiar signals, could thereby get a considerable pull over their adversaries. You (my readers) or I may consider that that would be cheating, but the inventors would, of course, deny it, and quote Clay as their justification, for does he not say, "It is fair to give to your partner any intimation which could be given if the cards were placed on the table each exactly in the same manner as the others by a machine, the players being out of sight and hearing of each other?" And could not the suggested conventions be as well played in the manner he thus specifies as fair, as any of the existing conventions? Certainly they could, and thus it comes home to us that Clay's argument, which has so constantly been relied on as establishing the fairness of signals, is unsound, and even if it be considered that he assumed that signals were only "fair" when known to or played by the other players, we should still feel—and I doubt not that every honourable man does feel—that to make use of signals against players who had never heard of them, and who, even if they had the genius of a Deschapelles, could not by any process of reasoning infer their exact meaning, would be unfair, and only a shade less unfair to use them against adversaries who might have heard of, but had never practised them, for the power of noticing the signals grows by practice, and a beginner is unable to discover them except by diverting his attention from other matters.

But, it may be asked, if conventions are both unscientific and to a certain extent unfair, how is it that any of them have been adopted? The answer is rather complex, but we can easily imagine that when such a convention as the signal for trumps was first suggested, whilst every one could see how useful it could be made, it would not at first sight strike players as being out of harmony with the spirit of the game, for after a man has played Whist for some time he draws inferences so rapidly as hardly to be aware of the process of reasoning. I must admit that my eyes were first opened as to their real character by the thoroughly fallacious reasoning of Cavendish on introducing the "penultimate"; besides, as soon as several men in a club determined to use the signal, the rest must either have declined to play with them, or else in self-defence have used it themselves; but probably

XUM

the principal reason of its being adopted was that the inferior players, always constituting a majority, would only be too glad to adopt anything which they could apparently use as well as the most gifted player. The worse the player, the less he understands or cares for the science of the game, and the more he regards it merely as a game of chance; but real lovers of the game want to preserve in it intact its power to interest us by making us reason, just as a mathematician enjoys solving a difficult problem, and hates to have the solution shown to him. These signals, however, deprive us of this interest by solving for us some of the most interesting problems that arise in the course of play; *e.g.*, one of them tells us when our partner wants trumps to be led, and another tells us very distinctly when we may, without risk, get rid of the highest card in order to unblock our partner's suit, and the very fact that it does so, is considered by its inventor and introducer as its great merit; for does not Cavendish, the arch-inventor of signals, after starting with the observation that "it has hitherto been left to the ingenuity of individuals to decide when and how to unblock their partners' suit," tell us that he has invented a signal, "the plain suit echo," to systematise the play to unblock? and thus, of course, put an end to all ingenuity in the process. Cavendish's views on signals may, I believe, be accurately stated as follows: "It is desirable to give your partner as much information as possible of the state of your hand; this or that mode of play can be utilised to give certain information. The idea is a good one, I will publish it in the *Field*, reissue the matter in a pamphlet, and then incorporate it in my treatise, which at present is a standard work; and if, after that, I can but get a few others to play it with me, we shall get such a pull by means of the information conveyed over those who will not play it, that they must follow!" At any rate, if this does not pass through his mind, it is the true history of one or two of the signals. Not one word can be found in any of his arguments that signals improve the game; but to every one who regards the game as a recreation, and not as a profession, this is the real question at issue, and the one on which I now propose to dilate.

I will assume for the purposes of argument, as is contended for so strongly by those who practise them, that signals give players who use them, an advantage over those who do not. Cavendish, in one place, calls the advantage "enormous;" but, as this advantage ceases as soon as all players use them, it can be no valid reason for adopting or inventing signals. The only reason for their introduction that I can think of is, that the conflict between rational and artificial play which they necessarily cause, as well as the additional information which they give, make the game more intricate and difficult, and thus give professors of it an increased (and, as I think, undue) advantage over amateurs; or, as Cavendish more delicately puts it: "No doubt moderate players may lack the quick perception which would enable them to take advantage of the American rules. This is no reason why better players should be deprived of that advantage!!" Certainly not, if the better players only played with their equals, or if they never played for money with the moderate ones; but some of us, at any rate, will think that after this Cavendish and the other better players who, not satisfied with natural advantages over moderate players, invent or practise artificial leads which increase these advantages, should, in fairness, give moderate players odds; and I shall wait with curiosity to hear if they do. They are making it a case of professionals *versus* amateurs. We are thus reduced to this proposition, that the adoption of signals either gives no advantage to one player over another, or an unfair advantage to the better players; if the latter, they ought to be avoided without further argument, and, if the former, there is no reason for introducing them. The game is a splendid game without them, and why not leave well alone?

One of the fairest and best tests whether signals improve the game or not, is to suppose that the construction of the game were so altered as to permit partners to give information (the sole object of signals) by showing to the table such cards as they chose, and this is just what Cavendish says he would like to do. Just consider how this most perfect way of giving information would largely deprive players of the opportunities of exercising their judgment or ingenuity. A and B being partners; A showing B King, Queen, and three small clubs; B would at once show Ace and a small one of the same suit, so that A might know that he could safely start with a small one. Again, A leading a suit, and remaining after one round with the second and third best and others, would show them, so that B, if he held the best, might get out of his way; whereupon B, if he had the best or fourth best, would at once show it to save A wasting one of his two good ones, and so on. Now would this be an improvement on Whist as it is? I think most decidedly not.

At present Whist is a pleasant recreation, whilst Double Dummy and Chess are hard work, and the suggested alteration would assimilate Whist to Double Dummy and make that a toil which is intended for pleasure; in this view I am not peculiar, for even F. H. Lewis, notwithstanding a deplorable readiness to adopt signals, says "the present tendency of Whist is to approximate the game more closely to Chess, by which Whist will lose not only its individual, but also its special educational character, and by which, as a game of relaxation, it will soon be a game of the past." This being the case, is it not the duty of every lover of Whist to resist to the utmost the introduction of new signals? and I am hoping that F. H. Lewis is taking his own words to heart, for I know that up to a very recent date he had not adopted the American leads. I could point out other ways in which signals spoil the play by diverting attention from more important points by making play slower and more laborious, and by inducing more fault-finding, for the more information is given the less scope there is for individual judgment (at D. Dummy no judgment can be exercised—the play is demonstrably right or wrong) and consequently the better player can more frequently prove, as a matter of fact, that the play of a particular card was wrong, and hence more wrangling and unpleasantness.

How much to be avoided some of the signals are, may be inferred from Cavendish's last treatise "Whist Developments," in which he explains what he calls the necessary drill for playing the American leads and the "plain suit echo." A system which requires players to go through the drudgery of reading such an inexpressibly dreary work, cannot be based on reason, nor be an improvement on the game; Cavendish really does try the staunchness of his followers in expecting them to read such a work. Its effect will, I hope and expect, be to seriously thin their ranks.

The two old signals of the call for trumps, and the return to a partner's lead, are doubtless too firmly established to be now ignored, but if the rising generation of players resolutely oppose the adoption of new signals, and give more thought to the special character of Whist, it may be hoped that these two will gradually fall into disuse, and that really scientific Whist based, and based only on rational deduction, will resume its sway, and instruct and amuse in the future even more generations of Englishmen than it has in the past.

## Recent Inventions.

[*We give here a brief description of such of the many recent inventions as we think may be of use to our readers. Where it is possible the number of the patent is quoted to enable those who desire fuller information to procure the specification from the Patent Office in Cursitor-street, Chancery-lane.*]

### ELECTRO-MECHANICAL CLOCK.

This invention, by Mr. Chester H. Pond, of the United States, is of an extremely simple nature, and one which promises to prove of great service to all sections of the community. Heavy springs or weights and cumbrous gearing are essential in the ordinary clock, because it has no automatic action, but must store its power for a long period. The tension varies from a maximum—when the clock is wound—to a minimum, when it must be wound again. This gives a more or less irregular action to the mechanism of the clock, and the stress of the springs or weights wears the pinions and bearings, throws the parts out of adjustment, renders a correct time impossible, and necessitates frequent repairs.

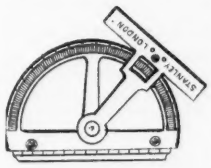
The electro-mechanical clock is an ingenious piece of mechanism, that winds itself automatically, and maintains a continuous action from year to year. It requires a small spring, but little larger than the mainspring of a watch, which is kept at a uniform tension, and acts directly on the hour-wheel, and not through a system of gear-wheels essential in the ordinary clock. This spring is wound in six seconds, and offers no interruption to the time while winding. It is kept only at a tension sufficient to run the clock one hour. It is then wound again by means of a small rotary electric motor, which is connected with the mechanism in a manner that gives to the clock a most symmetrical appearance. The electrical resistance of the coils on the motor is about five ohms. To drive it, an ordinary Leclanché cell, such as is used for electric bells, is employed. It is generally concealed in the frame or case of the clock, and is capable of furnishing the necessary current to wind the clock two years without attention. The hour-wheel, each hour of its revolution, switches the electric current through the motor, which rapidly revolves for six seconds, and communicates its rotary motion, by a gear-wheel, to the barrel on the centre arbor containing the spring. This barrel (in one revolution) imparts sufficient tension to the spring to run the clock one hour, stops the motor by breaking the electric current, and the battery rests for an hour, or until it is necessary to wind the clock again. This process is thus automatic and continuous, and the battery is used only six seconds each hour, or less than fifteen hours in a year. By this ingenious application of electricity the inventor has discarded the heavy springs and weights, and, therefore, the gearing necessary to transmit their power. He has

reduced the friction to one-ninetieth part of the amount in the ordinary clock. He has produced a more durable, accurate, and less expensive time-piece, which has also the merit of being silent in action and simple in its parts, requiring no expert to use it. If a large number of clocks are in use in one building, they can all be controlled and regulated by one clock, the battery necessary to wind up this one clock being sufficient to wind up any number of clocks in the building. The possible applications of this principle are almost innumerable. It is calculated that in the City of London alone there are 7,000 clocks wound by hand under a contract of a guinea a year per clock. The saving ensuing on the adoption of the new timepiece is apparent. The introduction of the invention to the English market has been entrusted to Mr. B. F. Watkins, of Room 29, Leadenhall-buildings.

## TINNE'S COMBINED PROTRACTOR AND SCALE.

In plotting a survey, traverse, or in similar work, it is ordinarily necessary to use several instruments in succession. First, a protractor to set off the bearing or angle; then a ruler to draw the intended line; then a scale laid along the line for the distance; and then, most probably, india-rubber to erase the part of the line which has been drawn in excess of what is necessary. In each of these several settings of protractor, ruler, and scale, not only is there considerable loss of time, but also a liability to a succession of inaccuracies, in spite of wearying care in setting each instrument with exactness as regards lateral and longitudinal position and angle.

In the instrument of which we here give an illustration these sources of error and loss of time are minimised. A small stock like an inverted T slides against the edge of a T square or parallel ruler, and has pivoted to it a protractor, on the edge of which is attached by two thumb-screws one of a set of ivory part-scales. By revolving the protractor against a vernier the edge of the part-scale can be set to any angle with the base of the stock, and there clamped by a binding-screw. The whole instrument (being now virtually a set square of the exact angle needed) is slid along the parallel ruler, and the ruler run too and fro, till the zero at one or other end of the scale of parts coincides with the points from which it is desired to draw a line. A pencil is then run along the edge of the scale exactly the distance required (and, of course, at the correct angle), and the point at which it stops becomes in its turn the point of departure for the next line, after the protractor has been set to the new bearing. As both protractor and scales are numbered to read from each end, bearings can be got at any angle "all round the compass," and distances counted off E., W., N., or S., and this without the slightest necessity of considering the whereabouts of the centre of the protractor.




This instrument is the invention of, and is patented by, Mr. Theodore F. S. Tinne, formerly of Auckland, N.Z., and is made and exhibited by Mr. William Stanley, mathematical instrument maker, of Great Turnstile, Holborn.

## FIRE-ESCAPE.

[Patent, No. 15,763. 1884.]—This invention, by Mr. E. H. Bayley, of 42, Newington-causeway, is one which, notwithstanding its recent introduction, has already established itself. It is based on the telescopic principle, and consists of three ladders, which, when occasion requires, are drawn by ropes and pulleys one above the other until a great altitude is attained. It has the advantage of being adjusted to any height within the extreme limits. In order to impart the necessary strength and rigidity, a specially-made steel wire rope is used above and below, while the stability is ensured by increasing the distance usually allowed between the carriage and the springs. Should any ladder-round be damaged, it can be replaced very readily, without taking the ladder apart. The apparatus is likely to prove quite as useful as a scaling-ladder as a fire-escape.

## DIVING BELTS.

[Patent No. 15563, 1884].—Mr. J. K. Tullis, of John-street, Bridgeton, Glasgow, has taken out a patent for an improvement in link-belting. In one class of the improved type the links are thinner in the centre than at the edges, an arched belt being thereby produced to suit the curve of the pulley. According to this manufacture, the entire face of the belt comes in equal contact with the entire face of the pulley. No unequal strain comes upon the rivets, as they have a level bed to lie upon. It may be made to suit any curve of pulley. This class of belt transmits, it is said, 25 per cent. more horse-power than a flat belt of the same width. A flat belt always retains a cushion of air between itself and the pulley, which prevents perfect grip. This air escapes through the spaces in the chain belt, and the edge leather takes full charge of the power which it has to turn.

Another class introduced is for half-twist belting. In using ordinary flat belts for this class of drive, it will be observed that a large portion of the belt assumes a slack appearance on the inside of the twist which leaves the pulley and does no work. Several plans have been tried to overcome this difficulty, such as splitting the belt up into two or three widths and securing them with cross connecting straps. But the most successful is the patent thick-sided and tapered chain belt. The links may be 1 inch deep at the one side, tapering to ⅜ inch deep at the other. By this formation a twist belt can be made to any width. It comes in contact with every inch of the pulley. The strain is taken up by the heavy side, the slackness is taken out, and the belt seems to work as well as if there were no twist to contend with.

## AUTOMATIC PRESSURE-CHANGING GAS GOVERNOR.

[Patent No. 188.]—The principal object of this invention (by Mr. Caink, of 2, Westbourne-terrace, Malvern Link,) is to secure a means by which the pressure of gas in the mains issuing from the gas governor may be increased and diminished automatically, at such times and to such extent as the consumption of gas supplied therefrom requires, and thus prevent what frequently happens—an excess or deficiency of pressure, arising from the impossibility of the man in charge at the gas-works being able always to anticipate the precise time and extent the pressure is required, consequent on the variation of the consumption which takes place in a town from time to time.

The apparatus may be applied to any of the usual forms of governors, which are generally constructed for the purpose of maintaining a uniform outlet pressure with a variable inlet pressure and consumption.

The gas-holder of the Governor is usually provided with an air-vessel, which counteracts the weight of the holder and valve, giving buoyancy thereto. In this Governor the air-vessel is divided into a series of chambers A A′, annular and concentric; the divisions which separate the chambers extend from the top to within a short distance (about ½ inch) of the bottom, the openings at the bottom being the only communication between the various chambers. From the top of each of the chambers rises a tube B B, extending, gas tight, through the gas-holder, and provided with a screwed plug or cap for the purpose of rendering the upper portion of the air-chamber air-tight when required. One of the legs of a syphon-pipe C C, which has the lower end of each leg turned upwards or otherwise "sealed," extends from the bottom of one of the chambers through the top of holder; the other leg extends downwards, outside gas-holder tank, and terminates with its open end on a level with the open end of the other leg of the syphon. This arrangement enables the syphon, when once charged, to remain charged indefinitely, even though neither leg may be immersed in the water. A plug may be provided at the upper end of the syphon for the purpose of charging it, or it may be charged through any of the tubes B B, &c. An annular tank D D, in which the outer leg of syphon ascends and descends, surrounds the gas-holder tank of the Governor, but is separated water-tight from it. The annular tank is charged with water to near the level of bottom of air-chamber or float in holder, when valve is in its highest position, or closed.

The adjustment and action of the apparatus are as follows:—Screw the caps on the tubes rising from air-chambers, and charge syphon. Weight the Governor so as to give the minimum day pressure desired, then charge with water the outer tank B up to the level of mouth of syphon. Remove the plugs from the tubes of such of the chambers as shall, when charged with water to the required height, add such weight to the holder as shall give the night pressure required. This will be determined by observing what depth the Governor-holder descends under the usual night pressure with an average night consumption. As the consumption of gas increases the pressure in the mains is thereby lowered, and (as is also the case in an ordinary gas governor) the holder and valve descend. The descent of the holder brings down with it the syphon, the outer leg of which becomes immersed below the level of the water in outer annular tank. The effect of this is to transmit water through syphon into such of the chambers as, by the removal of the plugs from the tubes, are in communication with the external atmosphere. The water continues to rise in the chambers until it attains the same level as that in the outer tank. Hence the greater the draught upon the mains the greater the descent of the holder, and consequently the greater the depth of water transmitted to the chambers and the greater

XUM

the pressure communicated thereto. When the consumption or draught upon the mains diminishes, the pressure therein increases, which raises the holder, and consequently lifts the water in the chambers above the level of the water in outer annular tank. The result is that water flows back from the chambers through the syphon, returning to the tank, removing the weight from the holder, and consequently diminishing the pressure. The action at first sight appears somewhat paradoxical, since the increase of pressure is made to produce a decrease, and the decrease is made to produce an increase. By dividing the air-vessel into chambers of various widths and making the proper combination, a maximum pressure of any number of tenths, depending upon the depth of the float, may be obtained. If it be desired that the pressure shall not begin to increase until the valve has opened to a given extent, it may be accomplished by lowering the water in the outer tank to the level at which it is required the increase should commence. If it be desired that the increase of pressure should cease on a given pressure being obtained, it is accomplished in the following manner:—Supposing the area of outer annular tank D equals area of gas-holder of Governor, then for every tenth of an inch of water transmitted from D to holder there will be one-tenth pressure communicated to Governor. H is a vertical pipe (reaching above level of water) in which syphon ascends and descends. J is a pipe communicating with bottom of H, having a gland at top in which a smaller pipe G, carrying a scale divided into tenths, slides water-tight, so as to be adjustable to any height. Let it be required to limit the increase of pressure to twelve-tenths. Slide G into J until its bell-mouth top is just twelve-tenths below level of water, as indicated by scale when holder is at its maximum height, that is, at the period of minimum consumption. It is obvious that when twelve-tenths depth of water, which produces twelve-tenths pressure on governor, has been transmitted from outer tank to holder, no further transmission can take place, however much farther the holder and syphon may descend, since the water, which can only reach the syphon through G, has descended to the level of top thereof. If it is desired to vary the rate of increase of pressure as the valve descends, it may be accomplished by suiting the curve or shape of the valve to the required variation.

Instead of the syphon for conveying the water from tank to annular chambers of float, a flexible pipe F may be employed.

When the apparatus has been adjusted to suit the gas supply of any system of mains, it will be seen that, with a uniform inlet pressure, a given opening of the valve will always be accompanied by the same outlet pressure; and since a given orifice, with a given pressure, discharges a certain known quantity of gas per hour, an indication either of the extent of the opening of the valve or of the degree of outlet pressure will be an indication of the rate of discharge.

### CLEANING KITCHENERS.

[Patent No. 5,126. 1884.]—Mr. L. Mills, of 71, West-street, Gravesend, has patented a plan for doing away with the dirty and unpleasant method at present in use for cleaning the flues of kitcheners and other ranges. It consists of a number of scrapers which are pivoted on the surfaces to be cleaned, and which are operated by handles placed in convenient places outside the grate. The scrapers, after removing the soot, automatically push open the soot-door and expel the soot.

### ELECTRIC METERS.

[Patent No. 9,801. 1884.]—Mr. F. Walker, of 36, Spondon-road, Tottenham, has patented a method of measuring the strength of a current of electricity flowing through a circuit, consisting of a low-resistance series solenoid and a high-resistance shunt solenoid; the latter solenoid is movable inside the former, and passes over a fixed iron core. When the current passes, the high-resistance solenoid is drawn into the other solenoid against a spiral spring of gauged tension. A lever with its fulcrum is attached to the high-resistance solenoid, and carries a stylus which traces upon a rotating drum a curve from which the electrical energy can be obtained. In another form each of the two solenoids has a moveable iron core attached to a lever carrying a stylus. Two curves are thus produced, one indicating the electro-motive force, and the other the current strength, the sum of the two curves at any ordinate representing the electrical energy.

### PURIFYING PARAFFIN OILS.

[Patent No. 13,446. 1884.]—This invention is by Mr. G. T. Beilby, of Midcalder, Midlothian. Shale or similar oils are mixed with alcoholic solution of caustic soda; this falls to the bottom, carrying with it the impurities. The supernatant oil contains an appreciable amount of alcohol, which is separated by distillation. The tarry matter mixed with the soda is steamed in a dephlegmating column to recover the remainder of the alcohol.

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1885-6.

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Jan. 4, 6, 8, Barrow-in-Furness; Jan. 11, 13, 14, Carlisle; Jan. 12, Hull; Jan. 15, Stockton; Jan. 18 to 22, Gilchrist Lectures; Jan. 26, Bradford; Jan. 27, Busby (Glasgow); Jan, 28, 29, 30, Edinburgh.

Feb. 1, 2, Edinburgh; Feb. 3, Alexandria; Feb. 4, Rothesay; Feb. 5, Chester; Feb. 6, 20, Malvern; Feb. 8, 12, 19, Cheltenham; Feb. 9, Hereford; Feb. 10, Walsall; Feb. 11, Wolverhampton; Feb. 15, Upper Clapton; Feb. 17, Reigate; Feb. 18, 25, London Institution; Feb. 22, Sutton Coldfield; Feb. 23, Uttoxeter.

March 1, 3, 5, Maidstone; March 3 (afternoon) and March (afternoon), Tunbridge Wells; March 8, 11, 13, 16, Belfast; March 8 to 27, in Ireland; March 29 to April 2, Gilchrist Lectures.


### *NOTICES.*

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